APPENDIX A

RECORD OF DECISION

SELECTED REMEDIAL ALTERNATIVE

Site Name and Location

Verona Well Field Site
Battle Creek, Michigan

Statement of Basis and Purpose

This decision document presents the selected final remedial action for the Verona Well Field Site in Battle Creek, Michigan developed in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986 (CERCLA), and, to the extent practicable, the National Contingency Plan. This decision is based on the administrative record for this site. The attached index identifies the items that comprise the administrative record upon which the selection of the remedial action is based.

Assessment of the Site

Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response action selected in this Record Of Decision, may present a current or potential threat to human health, welfare, or the environment.

Description of the Selected Remedy

The selected alternative for the final remedy will address the principal threats posed by the site. The remaining concerns include two source areas and the three contaminant plumes affecting the Verona Well Field. The specific components of the selected remedy include:

- Continued operation of the existing blocking wells and air stripper in the Verona Well Field;

- Installation and operation of additional purge wells downgradient of the source areas, and groundwater treatment (utilizing air stripping with vapor phase carbon) for extracted groundwater;

- Collection and treatment (utilizing air stripping with vapor phase carbon) of contaminated groundwater at the Thomas Solvent Annex and Grand Trunk Marshalling Yard Paint Shop source areas;

RECORD OF DECISION

REMEDIAL ALTERNATIVE SELECTION

VERONA WELL FIELD SITE
BATTLE CREEK, MICHIGAN

Prepared by

U.S. Environmental Protection Agency

Region V, Chicago, Illinois

June 1991

SUMMARY OF REMEDIAL ALTERNATIVE SELECTION

VERONA WELL FIELD SITE
BATTLE CREEK, MICHIGAN

I. SITE NAME AND LOCATION

The Verona Well Field Superfund site is located in the northeast section of the City of Battle Creek, Calhoun County, Michigan. The site includes the well field, three contaminant sources, and the groundwater between the sources and the well field (see Figure 1).

The Verona Well Field is the primary source of drinking water for the City of Battle Creek, a city of approximately 36,000 residents in south central Michigan. The well field also provides drinking water for several surrounding communities, for a total of approximately 53,000 residents, three major food processing industries, and numerous other commercial and industrial establishments.

The Verona Well Field is located on both sides of the Battle Creek River, within the gently rolling alluvial valley of the River. The valley floor is relatively flat and approximately one mile wide at the well field. The Battle Creek River flows southwesterly through the site towards its junction with the Kalamazoo River approximately 3 miles downstream. Its average flow rate at the well field is 200 cubic yards per second. The aquifer beneath the Verona Well Field consists of unconsolidated glaciofluvial sands from the Pleistocene period overlying Mississippian Age sandstone bedrock.

Prior to becoming contaminated, the Verona Well Field contained 30 production wells. Currently, thirteen of the original wells are used, however eight of those wells are under restricted use by the City due to the periodic presence of low levels of contamination. Three new wells were added in the northern part of the well field in 1984 by U.S. EPA as part of an initial remedial measure. Four additional production wells were added in 1990 by the City. Twelve of the original production wells have been converted into extraction wells to block contamination from moving northward in the well field (see discussion in section II.C.). In 1989, the average daily pumping rate from the well field was 12.7 million gallons per day.

The area surrounding the well field includes three residential areas containing single family dwellings, and pockets of light and heavy industry. The largest of the residential areas borders the well field to the south. The Grand Trunk Western Railroad (GTWRR) marshalling yard borders the well field to the east. A large undeveloped wetlands area is located north of the well field.

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- Installation and operation of soil vapor extraction (SVE) systems to remediate contaminated soils at the Annex and Paint Shop source areas;

- Continued operation and maintenance of the groundwater extraction system including the installation of additional groundwater extraction wells;

- Installation of a treatment system for extracted groundwater (utilizing air stripping with vapor phase carbon); and

- Implementation of groundwater, soil, surface water discharge, and air monitoring programs to monitor the treatment systems.

Declaration

As required by Section 121(a) of CERCLA, the selected remedy is protective of human health and the environment, attains Federal and State requirements that are applicable or relevant and appropriate for the remedial action, and is cost effective. This remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element and utilizes permanent solutions and alternative treatment technologies to the maximum extent practicable for this site. Because this remedy will not result in hazardous substances remaining on-site above health-based levels, the five-year review will not apply to this action.

State Concurrence

The State of Michigan concurs with the selected remedy for the Verona Well Field site. The letter of concurrence is forthcoming.

6/28/91.
Date

Valdas V. Adamkus

Valdas V. Adamkus
Regional Administrator

Further south beyond the residential area are the Thomas Solvent Company facilities, the Raymond Road facility and the Annex (see Figure 1). These two facilities and the GTWRR paint shop (located at the marshalling yard) are the identified source areas for the contamination at the Verona Well Field.

II. SITE HISTORY AND ENFORCEMENT ACTIVITIES

A. Site History

Contamination in the Verona Well Field was first discovered in August 1981 when a number of the City's supply wells were found to be contaminated with volatile organic compounds (VOCs). Subsequent sampling by the Calhoun County Health Department showed contamination in nearly half of the 30 supply wells as well as several private wells within the residential area to the south of the well field.

The Michigan Department of Public Health began sampling private wells in September 1981 and determined that 80 residential wells were contaminated. Several of the wells contained concentrations of total VOCs greater than 1000 micrograms per liter (ug/l), with one well containing greater than 3,900 ug/l of VOCs.

Following the discovery of contamination in the private wells, the affected residents were provided with bottled water and public showers. At that time, efforts began to connect affected residences to the City water supply. By early 1984, all affected homes and businesses had been connected or offered connection.

At the same time, the City of Battle Creek undertook actions to maintain its water supply. The most highly contaminated wells were removed from service, and water from less contaminated wells was blended with clean water. The City also attempted to remove contaminants from the groundwater by pumping water from two of the most contaminated wells directly to the Battle Creek River.

The site was added to the National Priorities List in July 1982. Initial studies conducted in and around the well field by U.S. EPA's Technical Assistance Team (TAT) contractor, and by Michigan Department of Natural Resources (MDNR), identified three sources of contamination: the Thomas Solvent Raymond Road facility, the Thomas Solvent Annex facility, and the GTWRR paint shop located in the marshalling yard (see Figure 1).

Contaminant plumes comprised of VOCs were also discovered to be migrating from the source areas toward and into the well field (Figure 2). VOC concentrations in the well field ranged from 1 to 356 ug/l. The major contaminants found at the source areas and in groundwater include Tetrachloroethene (PCE), Trichloroethene (TCE), 1,2-Dichloroethene (DCE), 1,1,1-trichloroethane (TCA), Benzene, to the railroad spur, and a small frame structure over the underground tanks (Figure 4). All three tanks and the building were removed by GTWRR in 1990.

Contamination of the soils and groundwater at the Annex reportedly resulted from leaking drums and surface spills that occurred during operations. The major contaminants detected at the site included PCE, TCE, DCE, TCA, Acetone, Ethylbenzene, Toluene, and Vinyl Chloride.

Grand Trunk Western Railroad Marshalling Yard

The Grand Trunk Western Railroad (GTWRR) marshalling yard is an extensive railroad switching yard containing approximately 30 sets of tracks and numerous other structures involved in the operation of the marshalling yard. Among the various buildings, there is a car repair shop, and a car department building, which includes the paint shop (see Figure 5). Solvents were used primarily for degreasing and cleaning as part of operations conducted in these buildings.

Contamination of soils and groundwater at the marshalling yard resulted from solvent disposal practices conducted in the 1960's and 1970's. According to employees of Grand Trunk, spent solvents were either dumped on the ground outside the car department building or disposed of in a drum pit. The drum pit, located just east of the paint shop, was a 55-gallon drum half buried in the soil with holes for drainage cut in the sides and bottom.

The major contaminants found at GTWRR were PCE and TCA. The solvent most commonly used by Grand Trunk was Dowclene, a commercially blended product containing PCE and TCA.

C. Response Actions

Well Field Blocking Wells

As discussed above, due to the contamination found in several production wells in the Verona Well Field in 1981, the City of Battle Creek shifted pumping to the northern most wells in the well field to avoid contamination. However, contaminants continued to migrate further northward, and by early 1984, 27 of the 30 supply wells were contaminated.

In an effort to mitigate the continued spread of contaminants and to provide the City with an adequate supply of drinking water, U.S. EPA and MDNR undertook an Initial Remedial Measure (IRM) in May 1984. The IRM consisted of the conversion of 12 of the southern most production wells into blocking (purge) wells, the installation of three new production wells in the well field, and the installation of an air stripper to treat contaminated water

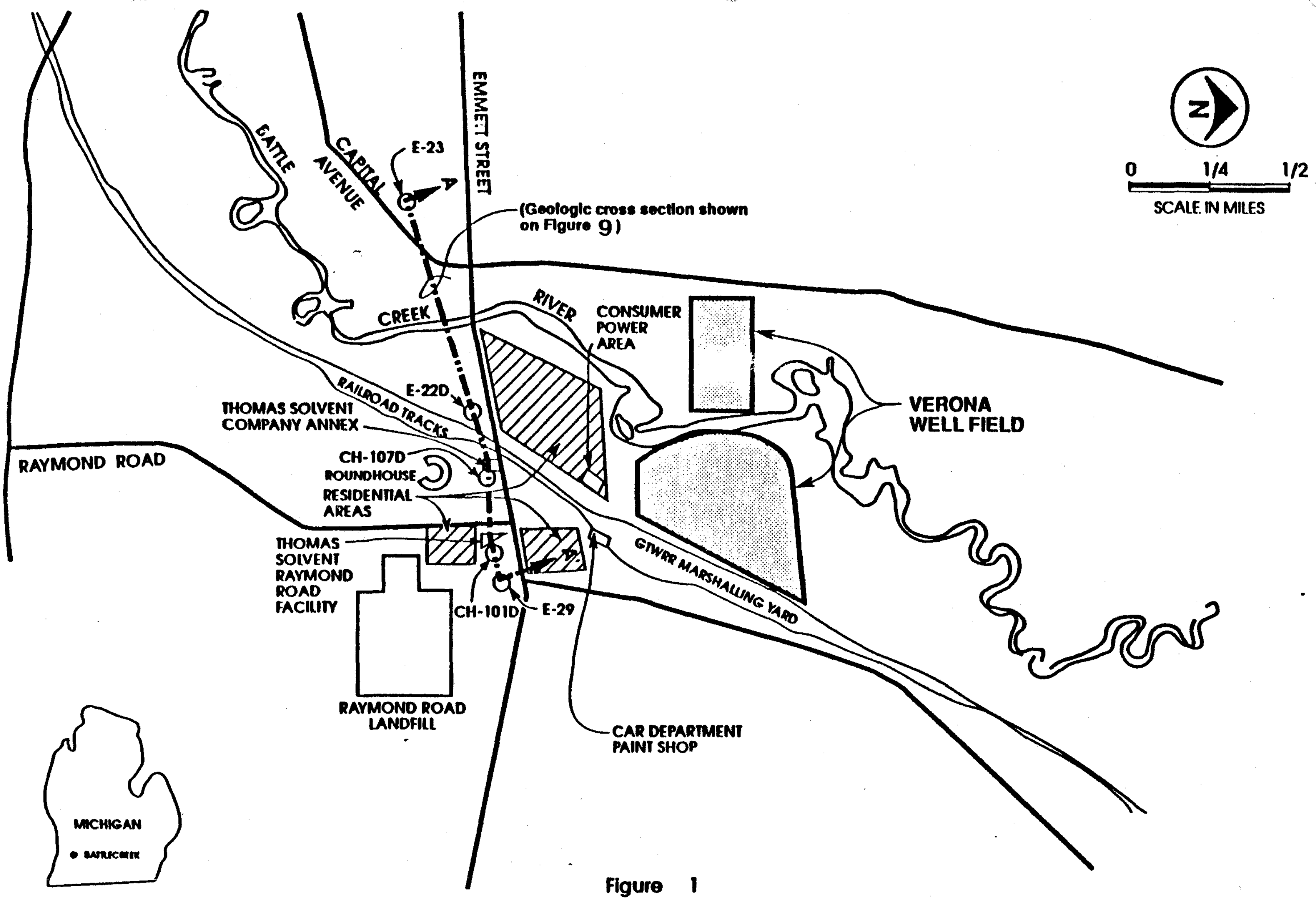


Figure 1
VICINITY MAP
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

Toluene, and Xylene.

The City of Battle Creek retained the U.S. Geologic Service (USGS) to conduct a hydrogeological study of the well field and to produce a groundwater model of the area. The model was used to simulate various pumping scenarios to characterize groundwater flow in the affected area.

B. <u>History of Source Areas</u>

Thomas Solvent Raymond Road

The Thomas Solvent Raymond Road (TSRR) and the Annex facilities were operated as solvent distribution and collection facilities by the Thomas Solvent Company from 1964 until early 1984. During the years of operation, industrial solvents were purchased, stored, blended, repackaged, and transported. The company also stored, transported and arranged for disposal of spent solvents from its customers.

Operations at the TSRR site, the company's primary facility, entailed the handling of virgin solvents, both chlorinated and nonchlorinated. TSRR contained the company's office, garage and warehouse. It also contained 21 underground storage tanks ranging in size from 4,000 to 15,000 gallons, used to store solvents (Figure 3). The tanks were emptied in 1984, and removed in early 1991.

Early investigations at the TSRR area revealed gross contamination of the soils and groundwater resulting from leaks in the underground storage tanks, leaking drums, and surface spills that occurred during operation. Contaminants found included PCE, TCE, TCA, DCE, Benzene, Toluene, Xylene, Acetone, Carbon Tetrachloride, Chloroform, and Methylene Chloride. In addition to contamination in soils and groundwater, a floating layer of nonaqueous phase liquid (NAPL) was identified at the soil/groundwater interface. This layer was comprised of pure solvents and mineral spirits released from the facility. The NAPL layer was reported to be greater than 4 feet at its thickest point. As a result of the initial investigations, TSRR was identified as the most significantly contaminated of the three sources.

Thomas Solvent Annex

The Annex was located on property leased from GTWRR to Thomas Solvent Company from 1963 until 1984. The Annex facility operation consisted primarily of the unloading of solvents from railroad tank cars, but also served as a storage area for barrels of spent solvents. In addition, the Annex contained two underground storage tanks, a 20,000-gallon above ground tank, a loading dock for barrel storage, a truck turnaround area, a solvent transfer area adjacent

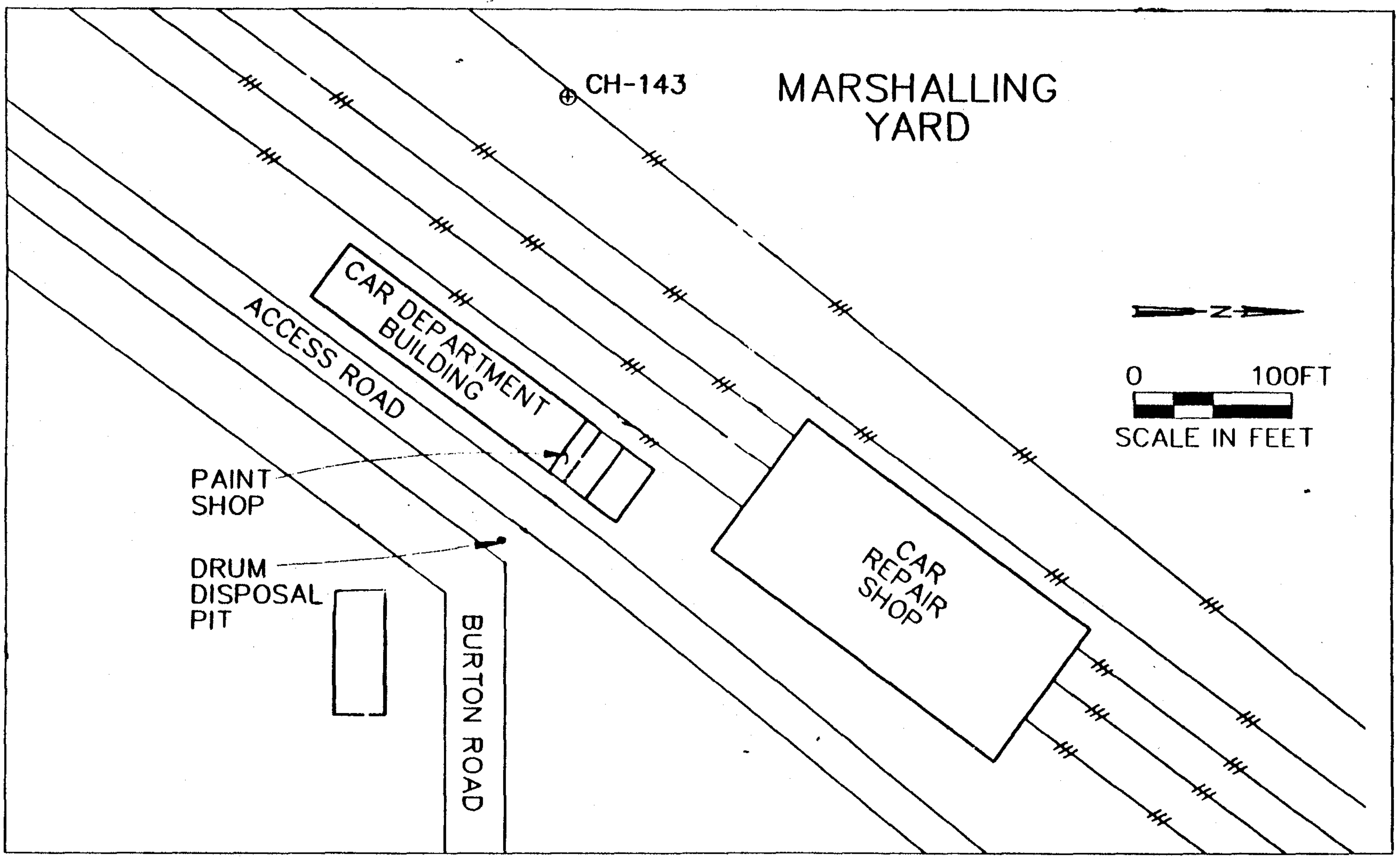
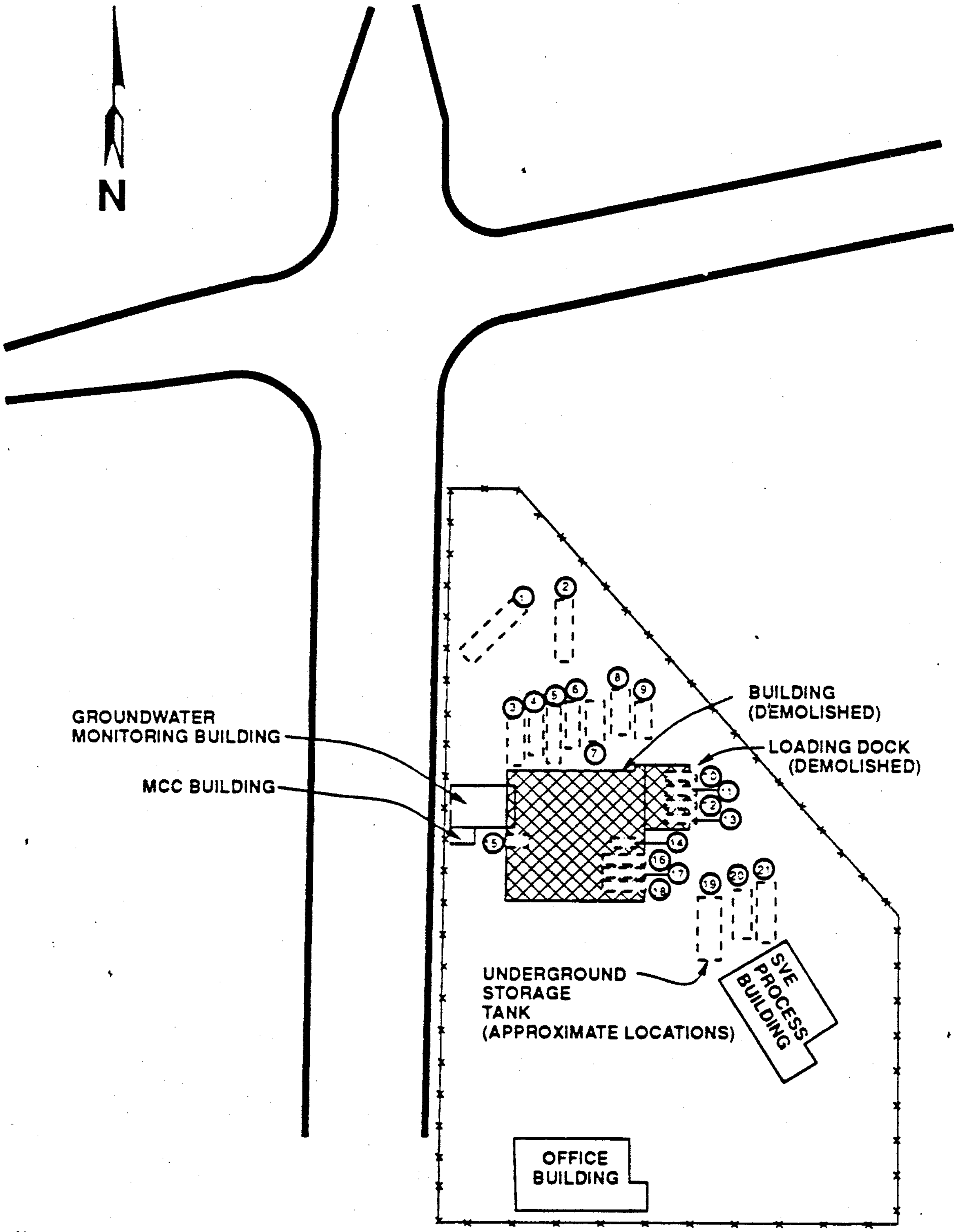


FIGURE 5
GRAND TRUNK WESTERN RAILROAD CAR DEPARTMENT
PAINT SHOP AREA
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN



Note:

= Tank number; corresponds with tank numbers

Figure 3
Thomas Solvent Raymond Road

extracted by the blocking wells.

The blocking wells are designed to intercept contaminants as they enter the well field from the south thereby preventing the contamination from reaching wells north of the blocking wells. Of the 12 production wells converted to blocking wells (V18 through V29), six wells presently serve as the blocking line (V22, and V24 through V28). Total flow from the blocking system is approximately 1500 - 1700 gallons per minute (gpm). See Figure 2 for location of blocking wells in the well field.

Water from the blocking wells is treated in an on site air stripper and discharged to the Battle Creek River. Extracted water from the blocking wells is piped to a wet well and then pumped to an air stripper for treatment. Off gas from the stripper is treated on two vapor-phase carbon adsorption vessels. The activated carbon in the vessels is periodically regenerated to destroy contaminants.

The installation of the blocking wells was completed in May 1984 and construction of the air stripper was completed in September 1984. During the interim period, a temporary activated carbon system was used to treat the water extracted from the blocking wells.

The IRM also included installation of three new production wells to ensure an adequate supply of drinking water and to help replace water supply capacity lost in creating the blocking line. The wells, V51, V52, and V53, were installed north of the existing production wells in the well field. The capacity of the wells is approximately 6 million gallons per day. These wells were in production by July 1984.

As early as October 1984, MDPH reported that 14 of the City's wells were uncontaminated. Since that time, the City's "tap" has been at or below detection limits for VOCs. The blocking wells have remained in operation to date, and the City of Battle Creek presently uses 18 of its wells for water supply production. Of these, 10 are identified as uncontaminated and 8 are under restricted use by the City due to periodic or potential contamination. Contamination in these wells is due in part to other sources including spills and leaks from gasoline stations in the area. In addition, since 1984, there have been a number of low level VOC detections north of the blocking line in the well field. Although the actual cause of these incidents of contamination has not been determined, migration of contaminants through or around the blocking wells is suspected. Alternately, it may be a result of residual contamination from before the blocking line was installed.

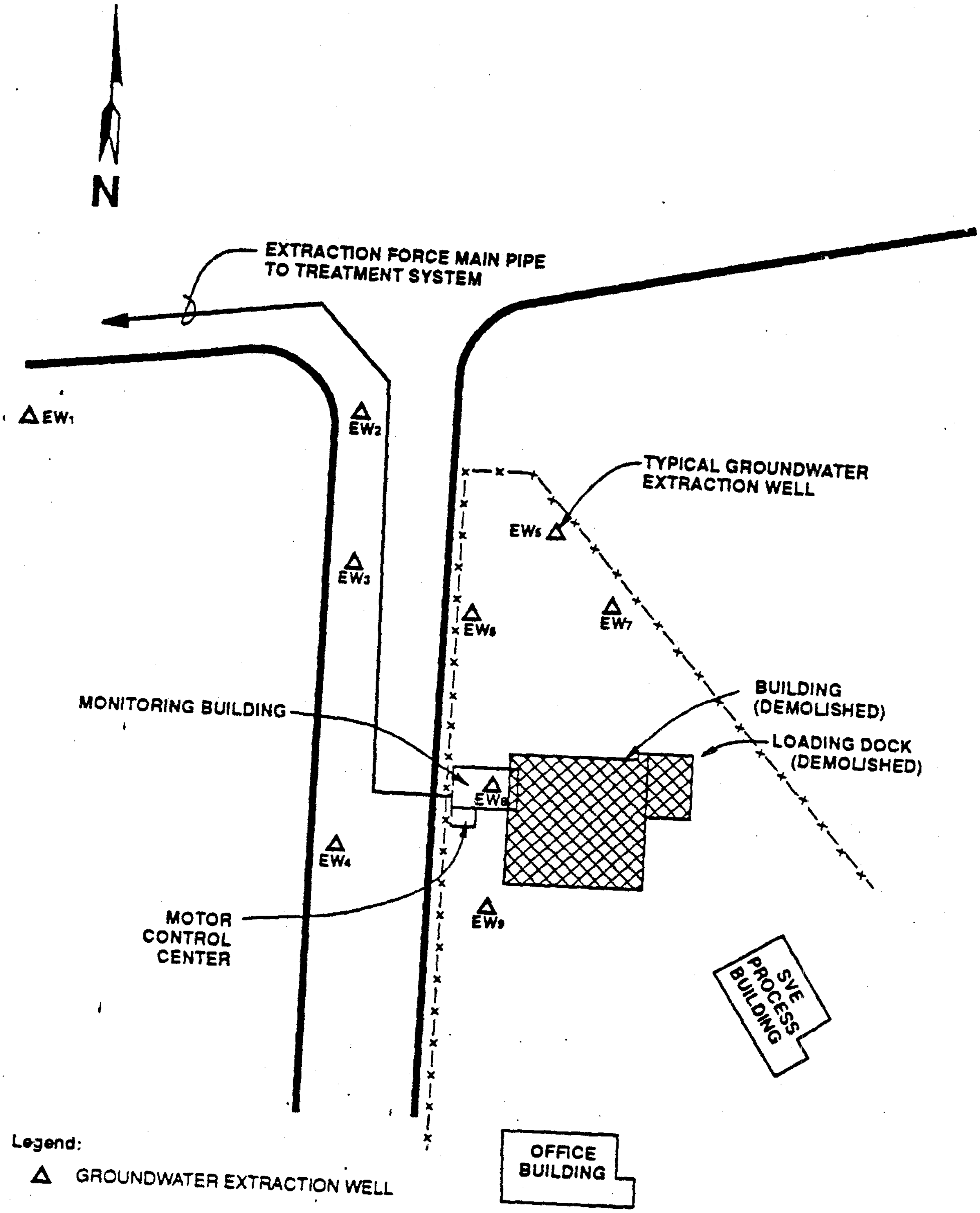


Figure 6
Groundwater Extraction System Layout
Thomas Solvent Site

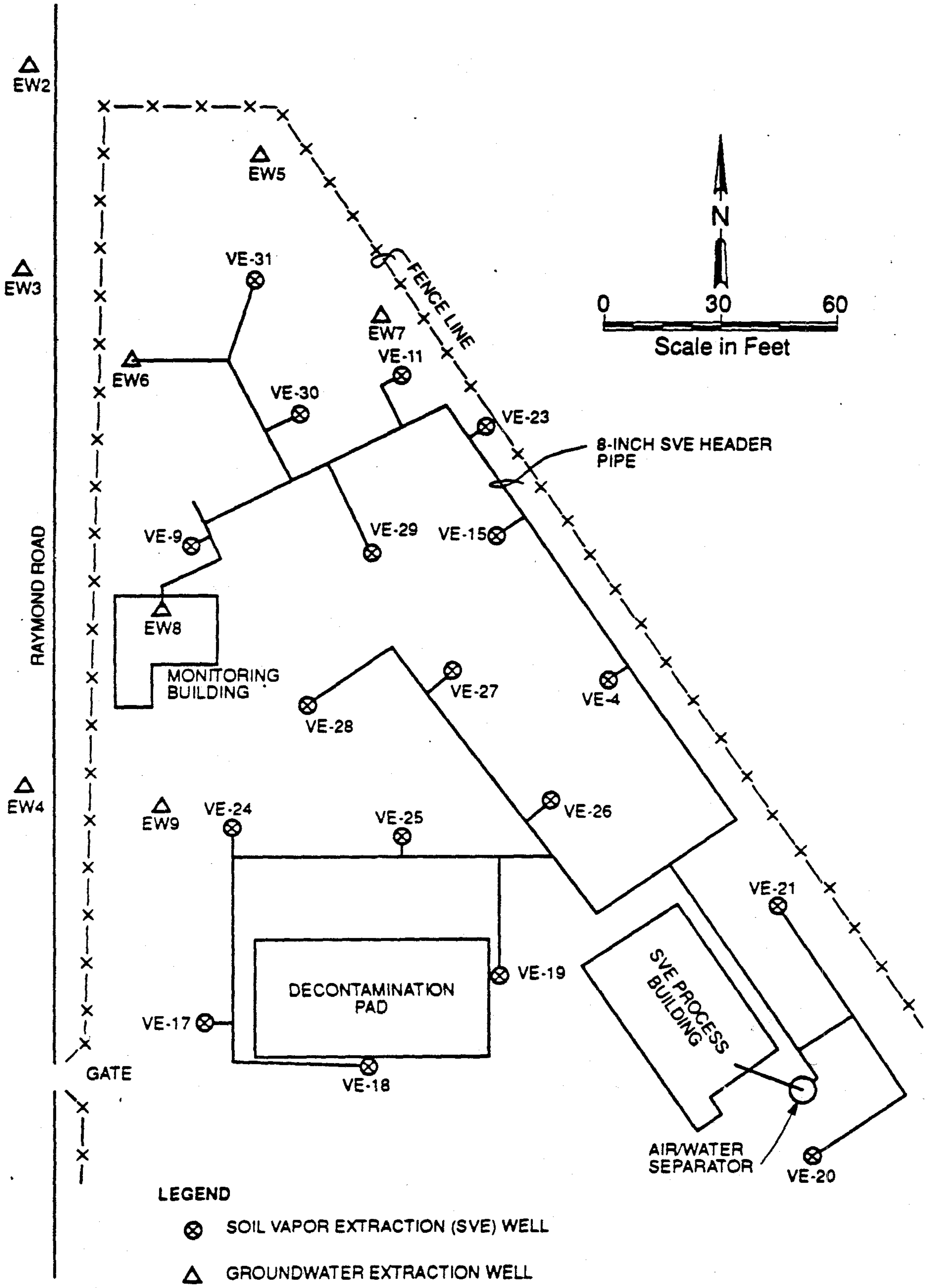


Figure 8
Soil Extraction System
Thomas Solvent Site

Source Remediation at Thomas Solvent Raymond Road

In August 1985, U.S. EPA finalized a Record of Decision (ROD) for the remediation of soils and groundwater at the TSRR facility. This was an operable unit ROD to deal immediately with the most severely contaminated of the three source areas. The ROD called for soil vapor extraction (SVE) with off gas treatment for soils and groundwater extraction (GWE) and treatment for contaminated groundwater.

The GWE system originally consisted of nine extraction wells installed at the TSRR facility and immediately downgradient. Currently, eight extraction wells are operational (see Figure 6). The wells, finished in the unconsolidated sands, remove approximately 350 gpm of contaminated groundwater from the site. The water from individual wells is pumped to a common header before being pumped to the wet well and the existing air stripper at the well field for treatment. During the first six months of operation, water from TSRR required pretreatment with aqueous carbon prior to air stripping due to the high level of contamination in the extracted groundwater.

The GWE system has been operational since March 1987. Through December 1990, approximately 14,000 pounds of priority pollutants have been removed through the GWE system. Total VOC concentrations have decreased from greater than 19,000 ug/l to less than 1000 ug/l.

The SVE system removes contaminants from the unsaturated soil zone by vacuuming soil vapor from the soil through extraction wells that extend from the ground surface into the top three to five feet of the water table. The system includes the extraction wells, an air/water separator, off-gas treatment equipment, and two vacuum pumps. Figure 7 shows a simplified schematic of the SVE system. The SVE system at the TSRR facility originally consisted of 23 wells. Following removal of the underground storage tanks in January 1991, the SVE system was rebuilt and now includes 20 wells, two of which are dual extraction wells (see Figure 8).

Off gas treatment of soil vapors was originally accomplished using carbon adsorption. In January of 1990, carbon was replaced with catalytic oxidation (CATOX), a form of vapor incineration. The CATOX unit provided more cost effective treatment of vapors and provided for contaminant destruction on site. Following tank removal in January of 1991, the CATOX unit was replaced by carbon. Due to greatly reduced levels of VOCs in the off gas, it is now more cost effective to use carbon adsorption.

The SVE system was pilot tested in November 1987, and full-scale operation began in March 1988. Through December 1990, the SVE system has removed approximately 45,000 pounds of priority pollutants. VOC concentrations have been steadily decreasing from over 1,000 pounds per day initially, to less than 10 pounds per day currently. Total VOC concentrations in the off gas have decreased from 23,000 ug/l in April 1988 to 38 ug/l in September 1990. As a result of this remedial action, the contaminant levels at the TSRR facility have been dramatically reduced.

D. Remedial Investigation/Feasibility Study

The U.S. EPA began its initial remedial investigation (RI) work in November 1983. The purpose of the initial RI work was to identify sources of contamination to the well field and to characterize the contamination at the site. This RI work was separated into two phases, the results of which were published in technical memoranda dated November 1984 and May 1985 respectively.

In February 1984, in response to the worsening conditions in the well field U.S. EPA initiated a focused feasibility study (FFS) to address the water supply problem, while the RI for the overall cleanup proceeded. In May 1984, U.S. EPA finalized the ROD to implement the IRM at the well field (see discussion in Section IIC).

In February 1985, U.S. EPA determined that source control at the TSRR facility should be implemented because of the severity of contamination identified at that facility. A phased feasibility study (PFS) was completed in May 1985, and a ROD finalized in August 1985 (see discussion in Section IIC).

The results of the initial RI work were memorialized in a draft RI report dated March 1986. This RI report was never finalized because U.S. EPA determined that additional RI work was needed to completely characterize the site.

In 1987, U.S. EPA approved the work plan for the final phase of RI work. Field work was conducted between December 1988 and August 1989. The RI report and baseline risk assessment for the site were published in August 1990. The feasibility study (FS) and the proposed plan (PP) for the final remedy were released for public comment in February 1991. The results of the final RI/FS are discussed in the following sections.

E. Enforcement Activities

Initial enforcement efforts focused on two identified potentially responsible parties (PRPs), Thomas Solvent Company (TSC) and Grand Trunk Western Railroad (GTWRR). Both PRPs declined to conduct the RI/FS in April 1983, and both declined, in April 1984, to undertake the immediate removal/IRM in the well field.

In January 1984, the State of Michigan filed suit against TSC in State court. That lawsuit sought, among other things, court ordered abatement of groundwater contamination. In March 1984, the Calhoun County Circuit court ordered TSC to install and operate groundwater extraction wells at the TSRR facility.

In February 1984, U.S. EPA issued a unilateral Section 106 Administrative Order to TSC to remove a floating product layer from beneath its Raymond Road facility. TSC complied with the order initially, and 500 gallons of contaminated water were removed from the site.

However, in April 1984 TSC filed a Chapter 11 petition under the Bankruptcy Code. U.S. EPA and the U.S. Department of Justice (U.S. DOJ) filed a proof of claim based on money owed to the federal government by TSC for costs spent at the site. As a result, a settlement was embodied in a stipulation that was entered by the bankruptcy court in November 1986, and the government recovered a portion of the bankruptcy court estate.

In May 1986, the United States and the State of Michigan each filed civil actions in the United States District Court for the Western District of Michigan against TSC, GTWRR, and several corporations associated with TSC for recovery of response costs incurred to investigate and remediate the Verona Well Field site.

In June 1989, a partial consent decree in the case was entered by the District Court in which GTWRR settled with the United States and the State of Michigan for 75 percent of past costs up to a specified date. As of December 1990, a second partial consent decree has been lodged with the Court which embodies an agreement between the United States, the State of Michigan and TSC et al. for payment of past response costs.

Based on the history of operations at the TSC Annex facility, U.S. EPA sent out information requests pursuant to Section 104(e) of CERCLA in April 1989. The 104(e) requests, which were sent to 65 companies and individuals, sought information regarding the recipient's knowledge of, and/or involvement at, the TSC's Annex facility.

In May 1990, the United States filed a second cost recovery suit in the United States District Court against 7 additional defendants to recover response costs related to the TSC Annex.

As is the practice of the U.S. EPA, Special Notice letters will be issued to initiate negotiations with PRPs following finalization of the ROD. The goal of these negotiations will be to reach agreement with the PRPs to implement the remedy called for in the ROD and to perform related operation and maintenance of the treatment systems.

III. HIGHLIGHTS OF COMMUNITY PARTICIPATION

Community interest in the problems at the Verona Well Field site has been very intense at certain periods during the progression of activities at the site. Beginning prior to the start up of the RI/FS, community activists staged protests against the handling of site by U.S. EPA and MDNR and expressed concerns over exposures of residents from private wells and the need for a clean water supply.

U.S. EPA and MDNR held several meetings and maintained frequent communication with the community, local officials, and members of the State legislature and U.S. Congress to resolve issues and discuss concerns. In addition, fact sheets were prepared by MDNR periodically to keep the community updated on site progress. A total of 20 progress reports were issued during the period between 1983 and 1987.

In November 1983, U.S. EPA held a kick off meeting to discuss the RI work to be performed. A public comment period was held on the FFS for remedial measures at the well field between March 29, 1984 and April 12, 1984. Copies of the FFS were made available to the public at the start of the comment period. A public meeting was conducted on April 5, 1984, and public comments received throughout the comment period were evaluated prior to finalization of the ROD in May 1984.

Following completion of the PFS for remediation at the TSRR facility, U.S. EPA published the document and began a public comment period that ran from June 17, 1985 through July 20, 1985. A public meeting was held to present results of the PFS and to solicit public comments. After consideration of public comments, the ROD was finalized in August 1985.

During the period from 1987 through 1990, U.S. EPA and MDNR held three separate "availability sessions" to discuss progress regarding the on-going remedial actions at the site.

In November 1990, the community applied for a Technical Assistance Grant (TAG) to hire a technical assistant to help them review site documents prepared for the final remedial action. The TAG was awarded to the community in December 1990.

The final RI report was released to the public in August 1990. The public comment draft of the FS for the final remedy and the proposed plan (PP) for site clean up were released February 15, 1991. This signaled the start of a 60 day public comment period. A public meeting was held on March 12, 1991 to present the findings of the FS and to accept comments on the FS and PP. The public comment period was scheduled to close April 15, 1991. However, U.S. EPA extended the public comment period to May 24, 1991 as a result of an extension request by one of the PRPs.

A response to comments received during the public comment period is included in the Responsiveness Summary, which is part of the ROD.

IV. SCOPE AND ROLE OF OPERABLE UNIT

The Verona Well Field site consists of three source areas of contamination and the contaminated well field. Previous actions have addressed protection of the well field through the implementation of a blocking well system (IRM), and remediation of soils and groundwater at one of the source areas, the Thomas Solvent Raymond Road facility (operable unit #1). The purpose of this final operable unit (#2) is to address the remaining concerns at all of the areas making up the site, and to set final cleanup goals for the Thomas Solvent Raymond Road source area and evaluate the effectiveness of the ongoing remediation there.

The Alternatives considered in the FS are intended to clean up the contaminated soils and groundwater at the Thomas Solvent Annex and the GTWRR marshalling yard, and to provide additional protection to the well field. They also address the clean up of groundwater between the source areas and the well field.

By addressing contaminated soils at the source areas, the selected remedy will address the principal threats at the site, and by cleaning up groundwater, will eliminate the primary health risks associated with the site. The project clean up goal is to reduce health risks to an excess lifetime cancer risk of 1×10^{-6} and a hazardous index of less than one for noncarcinogens in both soils and groundwater.

V. SITE CHARACTERISTICS

A. Geology and Hydrogeology

The unconsolidated deposits beneath the Verona Well Field consist of glaciofluvial sands of the Wisconsinan age. The sands are fine to medium, poorly sorted, with less than ten percent silts and clays. The bedrock consists of the Marshall Sandstone, underlain by the Coldwater Shale. The Marshall Formation is a light- to medium-gray, fine- to medium-grained, sandstone characterized by numerous joints, fractures, and bedding plane separations. The Coldwater Formation is a dark-blue-gray, sandy, silty shale. The thickness of the unconsolidated sediments ranges from 10 to 65 feet in the study area. The Marshall Sandstone varies in thickness between 100 and 120 feet in the area. Figure 9 presents a geologic cross-section of the study area.

The water table in the study area occurs in the glacial deposits between depths of 8 to 28 feet. There is no confining layer between the glacial sediments and the sandstone bedrock. Both units are used for water supply in the area around the well field. The glacial unit is used for private wells and the sandstone unit is used for municipal and industrial supplies. Production wells in the well field are cased through the glacial sediments into the sandstone. Below the casing, the wells are open bore holes. The majority of water from the sandstone is thought to come from fractures and bedding planes, since the rock itself is relatively fine-grained.

Hydraulic conductivities average 2.5×10^{-2} centimeters per second (cm/s) in the unconsolidated sediments and 1×10^{-2} cm/s in the sandstone unit. In the well field, conductivities in the sandstone have been recorded as high as .21 cm/s.

Natural groundwater flow is toward the Battle Creek River, however, pumping in the well field has greatly altered the direction of flow. Well field pumping has created a cone of depression which is up to 10 feet deep and extends the zone of the well field's influence horizontally to the south of the Thomas Solvent facilities, to the west of the marshalling yard, and east to the River. Groundwater flow paths are shown in Figure 10.

B. Nature and Extent of Contamination

Sampling during the remedial investigation included source area soil sampling and site wide groundwater sampling. The majority of the samples were analyzed for VOCs, however a limited number of samples were also analyzed for semivolatiles, pesticides, PCBs, and metals.

1. Site-wide Groundwater Investigation

The groundwater investigation focused on the source areas as well as groundwater downgradient of the sources and in the well field. The results of the groundwater sampling confirm that there are three separate plumes of VOCs migrating from the source areas that merge to the south of the well field prior to being captured by the blocking wells. The VOC plumes are shown in Figure 2.

The contaminant plumes migrating from the source areas appear to migrate vertically downward in the aquifer between the source areas and the well field. This phenomena is likely due to pumping in the well field. Vertical cross sections of the VOC plumes for each source area are shown in Figures 11 through 13.

The primary contaminants in all three plumes are chlorinated hydrocarbons although other VOCs have also been detected. Each of the plumes has a different composition related to the individual source area. These are discussed later in this section. In addition to VOCs, 20 different semivolatiles were also detected but only two (bis (2-ethylhexyl) phthalate and benzoic acid) were detected at multiple locations. Detections of semivolatile compounds were sporadic and did not indicate any pattern or plume of contamination. No pesticides or PCBs were detected in the study area and metals concentrations were within the background range expected for the area.

2. Thomas Solvent Raymond Road

The TSRR facility remediation was initiated in 1986 based on results of previous investigations. The site is approximately 1 acre in size, is fenced, and contains an office building, a process building for the vapor extraction treatment system, and the controls building for the groundwater extraction system. The soil vapor and groundwater extraction systems and their associated piping cover much of the site's surface.

The natural groundwater surface at the site is located between 14 and 16 feet, however pumping of the extraction wells lowers the water table to between 16 and 25 feet. The extraction system creates a 500-foot cone of influence in the glacial aquifer. Groundwater outside the radius of influence and in the sandstone unit flows towards the well field. Bedrock beneath the site occurs on the average of 35 feet below the water table.

Remedial investigation field work at TSRR was limited to sampling groundwater onsite, upgradient, and downgradient from the site. Soil borings have also been collected periodically as part of the ongoing SVE remediation. Seven onsite, 3 upgradient, and 14 downgradient wells were sampled. Results from the three rounds of groundwater samples collected from onsite monitoring wells are listed in Table 1.

Shallow onsite well B-18 contained the highest concentration of VOCs at 85,960 ug/l. This well is thought to be within the NAPL layer beneath the site. Other shallow wells onsite also contained high levels of VOCs, but intermediate well B-17I had very low levels. The primary contaminants are PCE, TCE, TCA, xylene, and toluene. Shallow and intermediate wells CH139S and CH139I are the most contaminated downgradient wells. They are located approximately 200 yards directly downgradient from the site, but are outside the zone of influence of the extraction wells. CH139S contained 22,300 ug/l VOCs, with the primary contaminants detected being vinyl chloride, 1,2-DCE, and 1,1-DCA.

The contaminant plume flows to the northwest toward the well field where it merges with the plume from the Annex facility. High concentrations of VOCs are found in the shallow wells at the source, and in intermediate and deep wells as it moves downgradient toward the well field. This vertical migration most likely results from pumping at the well field.

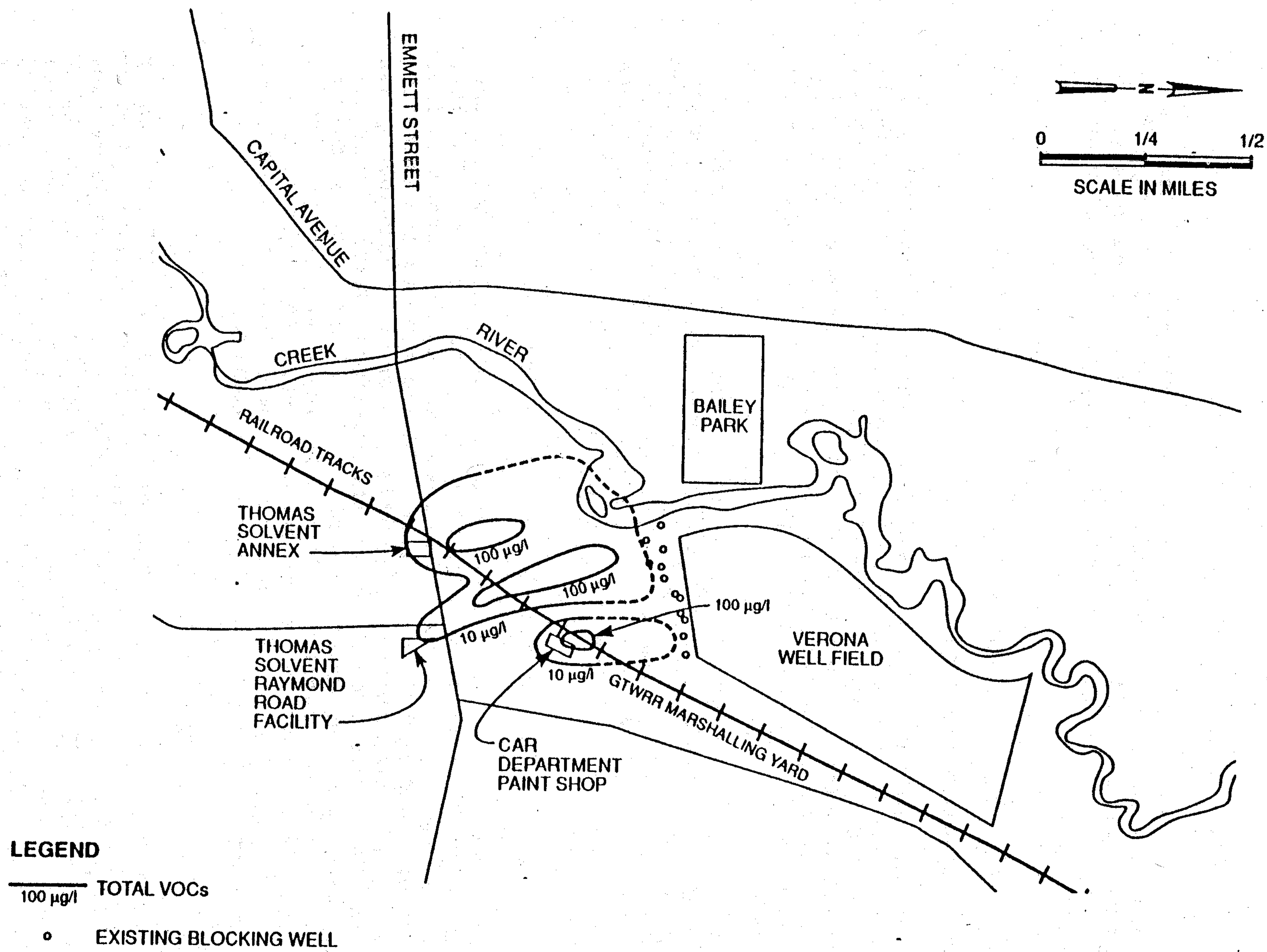


FIGURE 2
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

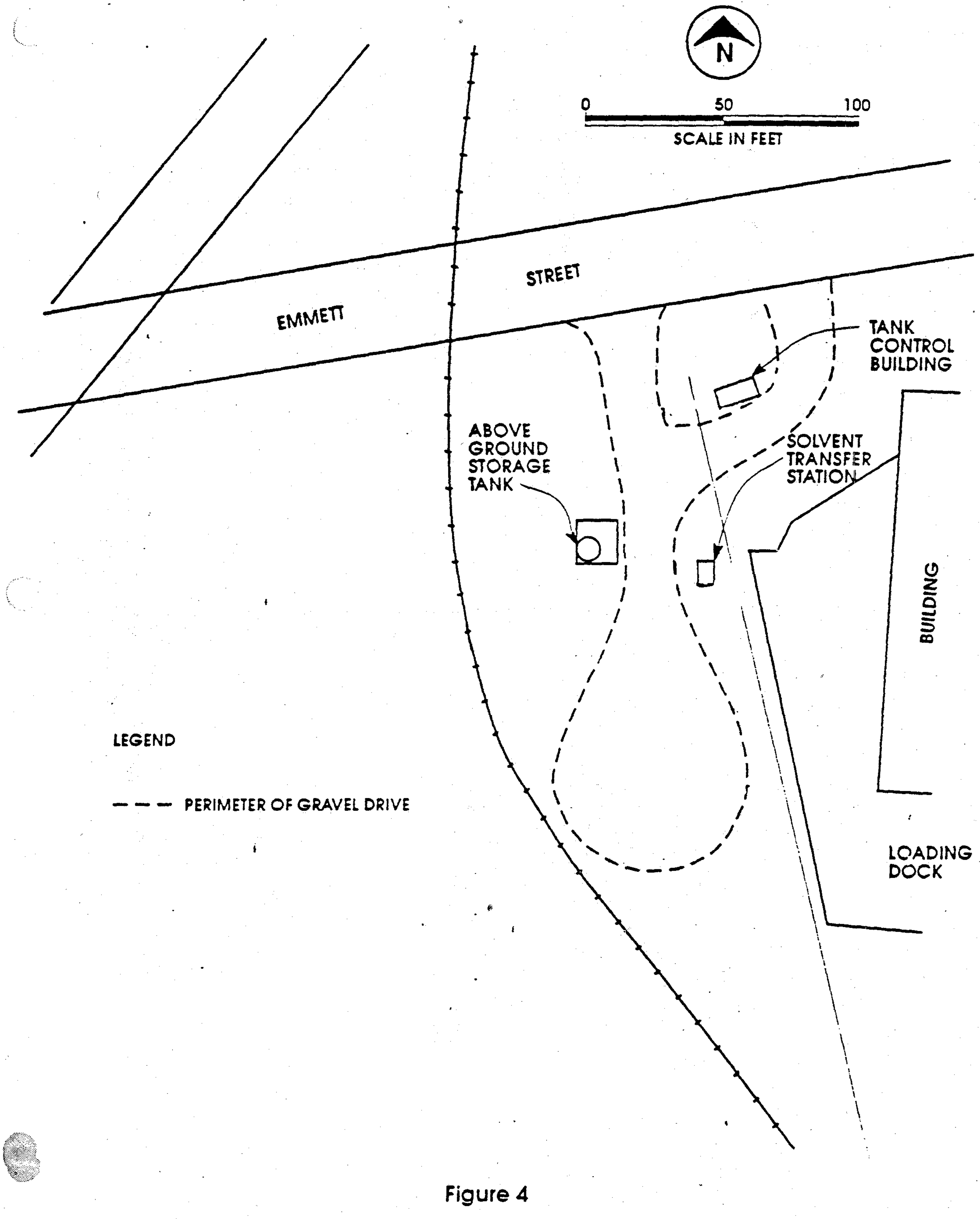


Figure 4

THOMAS SOLVENT ANNEX
VEPONA WELL FIELD
BATTLE CREEK, MICHIGAN

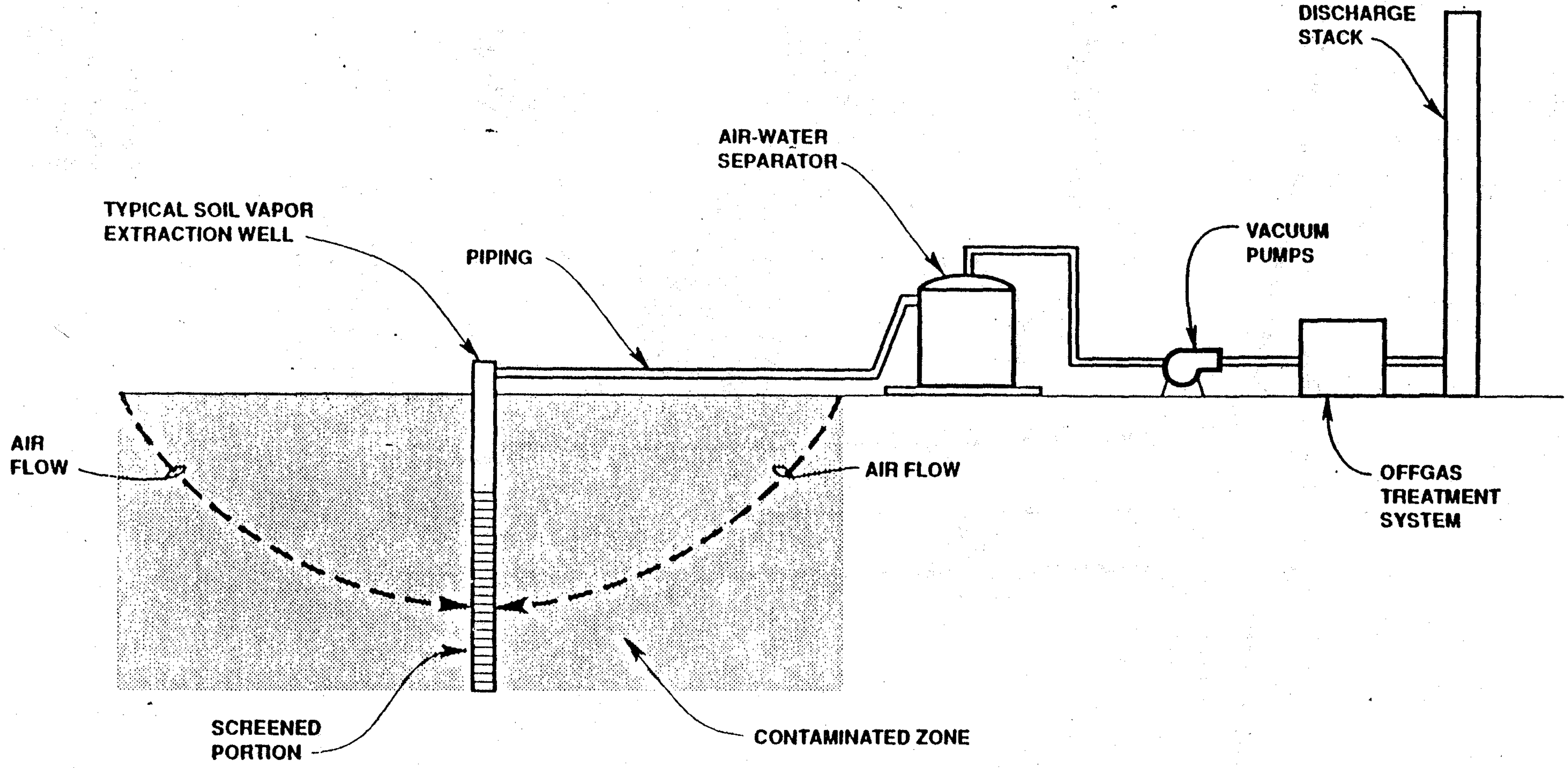
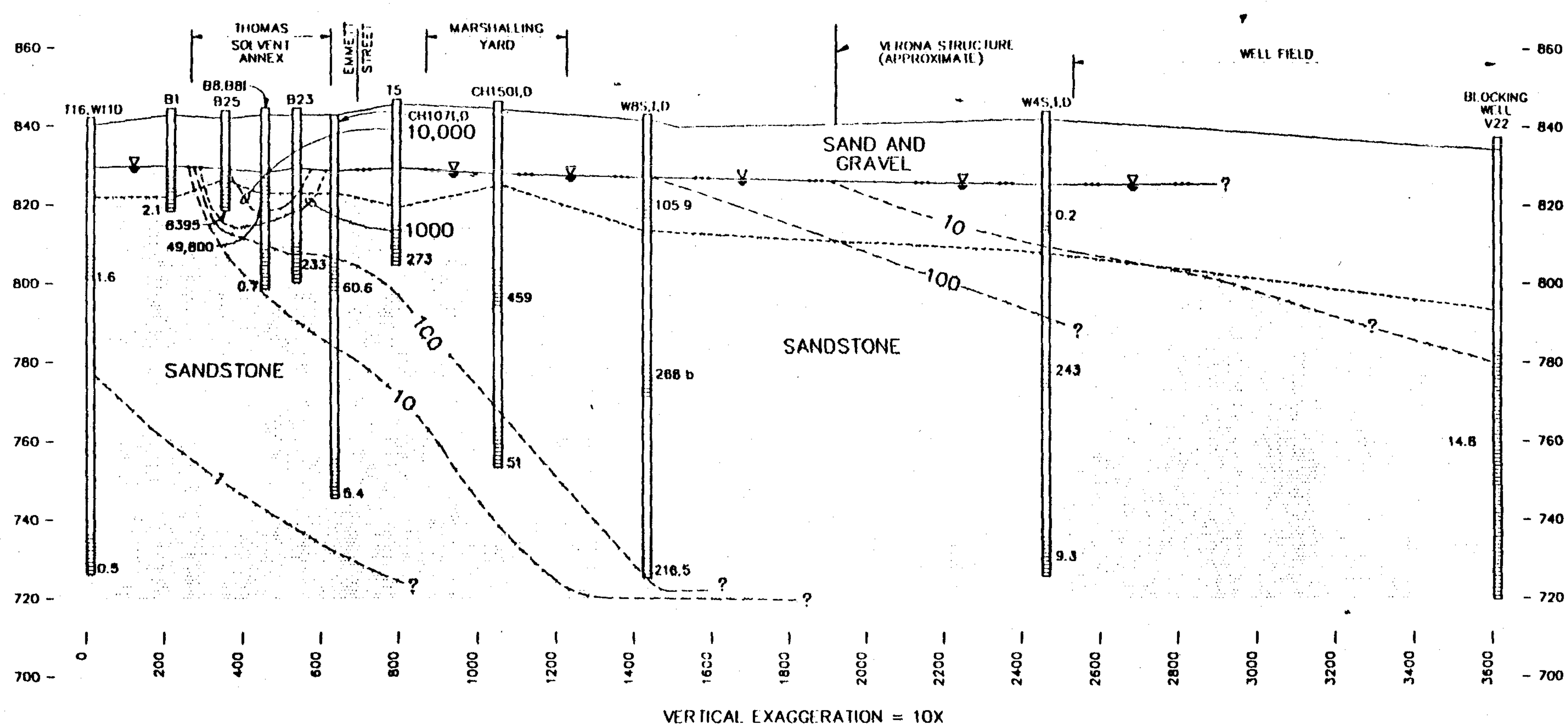


Figure 7
Schematic of Soil Vapor Extraction System
Thomas Solvent Site



NOTES:

1. CROSS SECTIONS ARE GENERAL IN NATURE AND DO NOT PURPORT TO BE AN EXACT REPRESENTATION OF SUBSURFACE CONDITIONS BETWEEN MONITORING WELLS.
2. QUESTION MARKS ON ISOCONCENTRATION CONTOURS INDICATE INFERRED VALUES. QUESTION MARKS BETWEEN GEOLOGIC UNITS INDICATE CONTACT IS INFERRED.
3. WELL DEPTHS AND SCREENED INTERVALS ARE SHOWN FOR ILLUSTRATIVE PURPOSES.

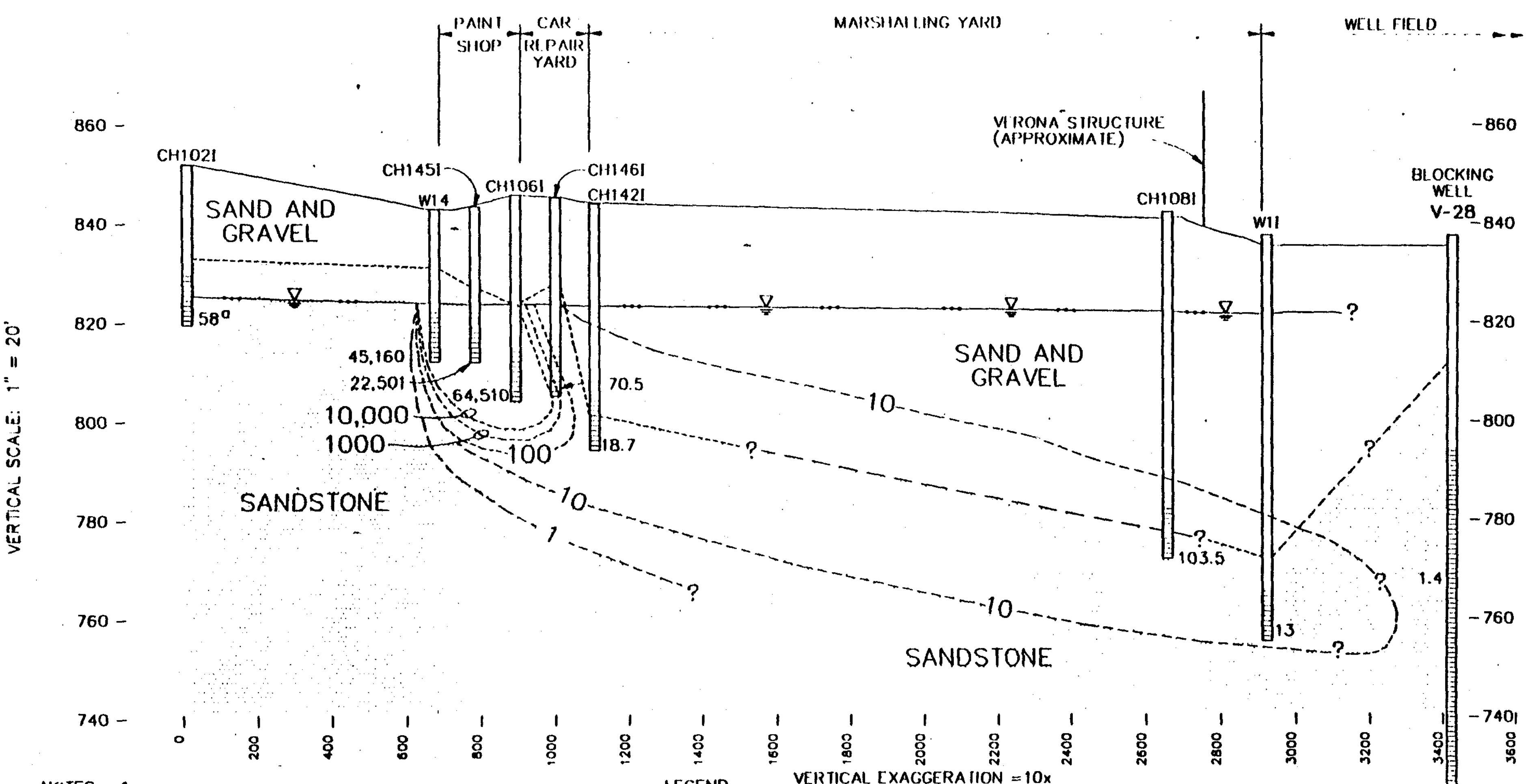
LEGEND

a	CONCENTRATION WAS ACETONE, WHICH WAS ALSO A LAB CONTAMINANT. DATA POINT IS TO BE CONSIDERED PRELIMINARY.
--10--	ISOCONCENTRATION CONTOUR. CONCENTRATION IS µg/L
∇	GROUNDWATER LEVEL DETERMINED FROM WATER LEVEL MEASUREMENTS OBTAINED ON APRIL 2 AND 3, 1989.
b	JUNE DATA WAS USED FOR CONTOUR

FIGURE 12

CROSS SECTION — TOTAL VOCs
THOMAS SOLVENT ANNEX
APRIL 1989

VERONA WELL FIELD
BATTLE CREEK, MICHIGAN



NOTES:
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a CONCENTRATION WAS ACETONE, WHICH WAS ALSO A LAB CONTAMINANT. DATA POINT IS TO BE CONSIDERED PRELIMINARY.

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▽ GROUNDWATER LEVEL DETERMINED FROM WATER LEVEL MEASUREMENTS OBTAINED ON APRIL 2 AND 3, 1989.

FIGURE 13
CROSS SECTION TOTAL VOCs
GRAND TRUNK PAINT SHOP
APRIL 1989
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

Table 1
GROUNDWATER ANALYTICAL RESULTS FROM
THOMAS SOLVENT RAYMOND ROAD ONSITE WELLS (ppb)

Compound	GWB21-02 EAL98 04/03/89 GRAB	GWCH127S- EDG34 04/04/89 GRAB	GWB17-03 EEE03 06/26/89 GRAB	GWB19-03 EEE06 06/26/89 GRAB	GWB20-03 EEE07 06/26/89 GRAB	GWB22-03 EEE09 06/26/89 GRAB	GWCH127S-03 EEE26 06/26/89 GRAB	GWCH127S-03 EEE70 06/26/89 GRAB
Chloromethane							1 J	1 J
Bromomethane								
Vinyl Chloride								
Chloroethane								
Methylene Chloride								
Acetone	470							
Carbon Disulfide			2					
1,1-Dichloroethene								
1,1-Dichloroethane		0.5					1 J	1 J
1,2-Dichloroethene						1		
Chloroform								
1,2-Dichloroethane		0.4						
2-Butanone								
1,1,1-Trichloroethane	18			1	11 D	2		
Carbon Tetrachloride								
Vinyl Acetate								
Bromodichloromethane								
1,2-Dichloroporpane								
cis-1,2-Dichloropropene								
Trichloroethene	37	0.6		3	17 D	5	1 J	1 J
Dibromochloromethane								
1,1,2-Trichloroethane								
Benzene		0.2						
trans-1,3-Dichloropropene								
Bromoform								
4-Methyl-2-Pentanone								
2-Hexanone								
Tetrachloroethene	280	4		16	100 D	77 D	3	2
1,1,2,2-Tetrachloroethane								
Toluene								
Chlorobenzene								
Ethylbenzene								
Styrene								
Total Xylenes								
Acrolein								
Acrylonitrile								
TOTAL VOCs	805	810.7	7.7	22	148	213	91	11

Concentrations are $\mu g/l$

Soil sampling at TSRR in 1987 indicated that soils in the area around the former warehouse and dock areas were contaminated from the surface to the water table at levels greater than 100 mg/kg of priority pollutant VOCs. The primary contaminants were PCE, TCE, TCA, acetone and toluene. The highest concentration of any compound detected in onsite soils was of PCE at 1,800 mg/kg. Soil and groundwater samples collected at the water table in 1987 indicated that the NAPL layer was still present. However, the most recent groundwater samples (during the RI) did not show the presence of this layer.

3. Thomas Solvent Annex

The Annex is approximately 1.25 acres in size, and currently contains only the loading dock structure. Groundwater is at 12 to 14 feet below the surface and flows northwesterly towards the well field. Bedrock occurs just below the water table at depths of 13 to 15 feet. Remedial investigation work conducted at the Annex included hand-auger (near surface) soil sampling, soil borings, and groundwater sampling.

The near surface soil sampling, which focused on three locations at the site, was conducted to determine the extent of contamination just below the surface. Results indicate contamination by chlorinated compounds below the loading dock, and in the vicinity of the old tank control building at three to four feet below the ground surface. Of the compounds analyzed, PCE, TCE, and TCA were the most prevalent. Concentrations of PCE ranged from 120 ug/l to 680 ug/l beneath the loading dock, and from 150 ug/l to 14,000 ug/l in the area of the tank control building. TCE ranged from 56 ug/l to 440 ug/l at the loading dock, and 400 ug/l to 880 ug/l at the tank control building. Concentrations of TCA were generally lower than the others with concentrations ranging from 7 ug/l to 93 ug/l at the loading dock, and 34 ug/l to 73 ug/l in the area of the tank control building.

Following the hand-auger sampling, 16 soil borings were drilled and sampled at the Annex. Locations of the borings were determined based on previous soil borings and on the results of the near surface sampling. The locations of the borings are shown in Figure 14.

Twelve different VOCs were detected in the soil borings above the detection limits. The most frequent contaminants found were PCE and TCE. Table 2 lists results of the soil boring samples along with boring numbers, locations, and sample interval. Borings SB-6 and SB-11 were the most contaminated of the borings with the greatest number of compounds present and the highest concentrations of most of the compounds. Boring SB-6 is in the area of the solvent transfer area and SB-11 is in the vicinity of the truck turnaround area.

TABLE 2
ANNEX SOIL BORING ANALYTICAL RESULTS (µg/kg)
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

SOIL BORING	INTERVAL (FT)	LOCATION	DCA	DCE	TCA	TCE	PCA	PCE	TOL	XYL	EB	MECL	2-BUT	ACE	TOTAL VOCS
SB-01	0-6	Tank Area	...	...	...	8900	...	54000	...	...	...	1400	...	...	64300
	6-12		...	...	...	...	...	1000	...	...	...	...	...	...	1000
	12-14		...	...	...	...	...	880	...	...	...	...	...	...	880
SB-02	0-6	Tank Area	...	410	400	7000	260	23000	...	...	...	...	...	...	31070
	6-12		...	...	...	640	...	2000	...	...	...	...	...	...	2640
	12-14		...	...	...	...	...	730	...	...	...	...	...	...	730
SB-03	0-6	Dock	...	690	...	630	...	8700	...	...	...	...	...	...	10020
	6-12		...	...	...	...	...	430	...	...	...	...	...	...	430
	12-18		...	300	...	...	...	660	...	...	...	...	...	...	960
SB-04	0-6	Dock	...	...	230	2500	...	2500	390	...	...	...	...	...	5620
	6-12		...	...	...	1300	...	1200	270	...	...	...	...	...	2770
	12-18		...	...	...	340	...	1400	...	...	...	...	...	...	1740
SB-05	0-6	Dock	...	...	...	11000	...	9100	230	...	...	...	...	...	20330
	6-12		...	...	...	6800	...	5700	...	...	...	...	...	...	12500
	12-18		...	...	...	760	...	7700	...	...	...	...	...	...	8460
SB-06	0-6	Transfer	2400	...	370	1100000	570	2100000	320	510	270	720	220	...	3205380
	6-12		260	...	...	2600	...	6100	...	...	...	...	...	...	8960
	12-14		1200	...	...	14000	...	16000	...	2400	750	650	...	...	35000

....

Compounds

DCA - 1,2 DICHLOROETHANE
DCE - 1,2 DICHLOROETHENE
TCA - TRICHLOROETHANE
TCE - TRICHLOROETHENE
TET - 1,1,2,2, TETRACHLOROETHANE
PCE - TETRACHLOROETHENE
TOL - TOLUENE
XYL - XYLENE
ED - ETHYLBENZENE
MECL - METHYLENE CHLORIDE
2-BUT - 2-BUTANONE
ACE - ACETONE
.... - BELOW CONTRACT REQUIRED DETECTION LIMITS

Locations

DOCK - LOADING DOCK
TANK AREA - UNDERGROUND TANK/TANK CONTROL AREA
TRANSFER - SOLVENT TRANSFER STATION
TURNAROUND - TRUCK TURN AROUND AREA

Results of the soil boring analyses indicate that contamination is present vertically throughout the unsaturated zone. Contamination was found in all three sample intervals at similar concentration levels. This even distribution of contaminants is indicative of multiple leaks, spills or discharges over time in various areas on the annex property.

Groundwater sampling at the Annex included 3 upgradient wells, 7 onsite, and 24 downgradient wells. The results of the samples collected from onsite monitoring wells are listed in Table 3; locations of the monitoring wells are shown in Figure 17. The groundwater contamination found at the Annex is similar to the soil sampling results discussed above. The contaminants are primarily chlorinated hydrocarbons and aromatics. Vinyl chloride, 1,2-DCE, TCE, PCE, toluene, ethylbenzene, and xylene were detected above 100 ug/l in at least one onsite well.

The most contaminated wells were shallow wells B-8, B-9, and B-25. Almost no contamination was found in intermediate wells onsite, and no contaminants were found with any regularity in the upgradient wells. In downgradient wells, concentrations were highest immediately downgradient of the site and decreased with distance away from the source toward the well field. Contaminants were found at higher levels in intermediate and deep wells downgradient of the Annex. This is likely a result of contaminants being pulled down vertically in the aquifer due to pumping in the well field (see cross section in Figure 12).

Monitoring wells between the Annex and the Battle Creek River were sampled to investigate the impact of groundwater contaminants from the Annex on the River. Low level contaminants were found in some of these wells (<5 ug/l VOCs), however, no definite plume was identified and contaminants are suspected of being residual levels from earlier plume migration toward the River. There does not appear to be a current impact on the River.

4. Grand Trunk Western Railroad

The car department shop is located on the eastern edge of the marshalling yard amongst several buildings. The marshalling yard is situated on the eastern edge of a glacial river valley. The thickness of the unconsolidated alluvium ranges from 15 to 20 feet below the paint shop, thinning to the east. Groundwater is at a depth of 18 to 20 feet, just below the bedrock surface which slopes to the west towards a bedrock valley on the western edge of the marshalling yard. Groundwater flow is to the north/northwest towards the eastern portion of the well field.

Remedial investigation work at GTWRR included hand-auger soil sampling, soil borings, and groundwater sampling from monitoring wells. The hand augering, or near surface soil sampling, was

Table [illegible] (Continued)

GROUNDWATER ANALYTICAL RESULTS FROM THOMAS SOLVENT ANNEX ONSITE WELLS (ppb)

Compound	GWB08-02 EAG62 04/06/89 GRAB	GWB081-02 EAG35 04/06/89 GRAB	GWB09-02 EAG36 04/06/89 GRAB	GWB23-02 EAG37 04/06/89 GRAB	GWB25-02 EAG38 04/06/89 GRAB	GWCH107I-02 EAL73 04/06/89 GRAB	GWCH107D-02 EAL72 04/06/89 GRAB
Chloromethane							
Bromomethane							
Vinyl Chloride						2	
Chloroethane							
Methylene Chloride			9	2			0.7
Acetone			100				
Carbon Disulfide							
1,1-Dichloroethene					9		
1,1-Dichloroethane				4	76	0.9	
1,2-Dichloroethene	12000		4700	71	2100	38	4
Chloroform							
1,2-Dichloroethane							
2-Butanone							
1,1,1-Trichloroethane	1100		50	2	820	0.9	
Carbon Tetrachloride							
Vinyl Acetate							
Bromodichloromethane							
1,2-Dichloroporpane							
cis-1,2-Dichloropropene							
Trichloroethene			110	52	970	7	
Dibromochloromethane							
1,1,2-Trichloroethane							
Benzene			40	2			
trans-1,3-Dichloropropene							
Bromoform							
4-Methyl-2-Pentanone							
2-Hexanone							
Tetrachloroethene	2100	0.7	260	100	520	10	0.7
1,1,2,2-Tetrachloroethane							
Toluene	3100		8		600	0.1 J	
Chlorobenzene			3				
Ethylbenzene	7500		51			0.6	
Styrene							
Total Xylenes	24000		30		3300	1.1	
Acrolein							
Acrylonitrile							
TOTAL VOCs	49800	0.7	5361	233	8395	60.6	5.4

Concentrations are µg/l

conducted at nine locations. Samples were collected at depths between 3 and 4.25 feet and analyzed for a short list of VOCs utilizing onsite laboratory equipment. Sample locations included the area of the drum pit and the area just east of the car department building. Results indicate shallow soil contamination by PCE and TCA in the area of the paint shop and drum pit.

Following the hand-auger sampling, soil borings were installed and sampled from the ground surface to the top of bedrock. Six borings were installed on the east side of the paint shop and four installed on the west side. Boring locations are shown in Figure 15. Analytical results for compounds detected in the borings are presented in Table 4. PCE, TCA, and toluene are the only compounds detected with any regularity. PCE was found in 28 of the 34 samples collected. Results indicate a decrease in concentration of contaminants both laterally and downgradient of the drum pit. The highest concentrations were found in the deepest soil borings which seems to indicate stratification of contaminants within the soil column.

The groundwater investigation at the paint shop involved sampling and analyzing groundwater from 7 onsite wells and a number of upgradient and downgradient wells. The three compounds most prevalent in the groundwater were PCE, TCA, and benzene. PCE and TCA were also found in the near surface soil samples and deep soil borings, and are known to be the components of Dowclene, the solvent used by GTWRR. Results from groundwater samples collected from onsite monitoring wells are presented in Table 5. Locations of monitoring wells are shown in Figure 18.

Contaminant levels in groundwater at the marshalling yard are highest closest to the drum pit and decrease downgradient. On the western edge of the facility, concentrations of contaminants in monitoring wells are two orders of magnitude lower than adjacent to the source. Results also indicate a downward vertical flow of the plume as it moves towards the well field. As with the other groundwater plumes, it appears this is a result of pumping in the well field.

VI. SUMMARY OF SITE RISKS

CERCLA requires that U.S. EPA protect human health and the environment from current and potential exposure to hazardous substances found at or emanating from the site. A base line risk assessment was conducted as part of the RI in order to assess the current and potential risks from the site. This section summarizes the Agency's findings concerning the risks from exposure to soils at the source areas, and groundwater at the source areas and downgradient in the vicinity of the Verona Well Field.

Assessment of site related risks involved the identification of

TABLE 4
PAINT SHOP SOIL BORING ANALYTICAL RESULTS
Detected Concentrations (µg/kg)
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

SOIL BORING	INTERVAL (FT)	LOCATION	BDCM	TCA	PCE	TOL	MECL	TOTAL VOCS
SB-21	0-6	East Side	- - -	- - -	260	- - -	- - -	260
	6-12		- - -	- - -	780	77	- - -	857
	12-18		- - -	160	1900	- - -	- - -	2,060
SB-22	0-6	East Side	- - -	- - -	2800	- - -	- - -	2,800
	6-12		- - -	- - -	3900	- - -	- - -	3,900
	12-16		- - -	620	8200	290	290	9,400
SB-23	0-6	East Side	- - -	- - -	760	- - -	- - -	760
	6-12		- - -	- - -	2700	- - -	- - -	2,700
	12-18		- - -	150	3200	150	- - -	3,500
SB-24	0-6	East Side	- - -	- - -	1400	- - -	- - -	1,400
	6-12		- - -	160	2400	- - -	- - -	2,560
	12-18		- - -	240	3200	- - -	- - -	3,440
SB-25	0-6	East Side	- - -	- - -	600	- - -	- - -	600
	6-12		- - -	- - -	1200	- - -	- - -	1,200
	12-16		440	- - -	9400	- - -	- - -	9,840
SB-26	0-6	East Side	- - -	- - -	440	- - -	- - -	440
	6-12		- - -	- - -	1700	- - -	- - -	1,700
	12-14		630	- - -	12000	- - -	- - -	12,630
SB-27	0-6	West Side	- - -	- - -	9900	- - -	- - -	9,900
	6-12		- - -	- - -	35000	- - -	- - -	35,000
	12-18		- - -	- - -	1100	- - -	- - -	1,100
	18-22		- - -	- - -	1800	240	- - -	2,040
SB-28	0-6	West Side	- - -	- - -	280	- - -	- - -	280
	6-12		- - -	- - -	- - -	- - -	- - -	0
	12-18		- - -	- - -	150	- - -	- - -	150
	18-20		- - -	- - -	3100	340	- - -	3,440
SB-29	0-6	West Side	- - -	- - -	- - -	- - -	- - -	0
	6-12		- - -	- - -	- - -	- - -	- - -	0
	12-18		- - -	- - -	1700	- - -	- - -	1,700
	18-20		- - -	- - -	4000	430	- - -	4,430
SB-30	0-6	West Side	- - -	- - -	- - -	- - -	- - -	0
	6-12		- - -	- - -	- - -	- - -	- - -	0
	12-18		- - -	- - -	- - -	- - -	- - -	0
	18-20		- - -	- - -	490	- - -	- - -	490

NOTES:

BDCM	Bromodichloroethane	MECL	Methylene Chloride
TCA	Trichloroethane	- - -	Below contract required detection limits
PCE	Tetrachloroethene		
TOL	Toluene		

Table 5 (continued)
GROUNDWATER ANALYTICAL RESULTS FROM THE GRAND TRUNK PAINT SHOP ONSITE WELLS (ppb)

Compound	GWW14S-02 EDG89 04/06/89 GRAB	GWCH106I-03 EEE24 06/28/89 GRAB	GWCH140I-03 EEE23 06/28/89 GRAB	GWCH145I-03 EEE29 06/28/89 GRAB	GWCH146I-03 EEE27 06/28/89 GRAB	GWW14S-03 EEE30 06/28/89 GRAB
Chloromethane						
Bromomethane						
Vinyl Chloride						
Chloroethane						
Methylene Chloride						
Acetone						
Carbon Disulfide						
1,1-Dichloroethene	160	5	2			
1,1-Dichloroethane		4			9	
1,2-Dichloroethene						
Chloroform						
1,2-Dichloroethane						
2-Butanone						
1,1,1-Trichloroethane	13000	78 DJ	98 D	5700		10000
Carbon Tetrachloride						
Vinyl Acetate						
Bromodichloromethane						
1,2-Dichloroporpane						
cis-1,2-Dichloropropene						
Trichloroethene		3				
Dibromochloromethane						
1,1,2-Trichloroethane						
Benzene				16000 DJ	3	
trans-1,3-Dichloropropene						
Bromoform						
4-Methyl-2-Pentanone						
2-Hexanone						
Tetrachloroethene	32000	460 D	190 D	2000 DJ	7	31000 DJ
1,1,2,2-Tetrachloroethane						
Toluene					2	
Chlorobenzene						
Ethylbenzene						
Styrene						
Total Xylenes					2	
Acrolein						
Acrylonitrile						
TOTAL VOCs	45160	550	290	23700	23	41000

Concentrations are μg/l

contaminants of most concern, routes of contaminant migration and populations potentially exposed to the contaminants. This information was then used to estimate exposure from contaminants for the population, which was then compared to chemical toxicity to arrive at an estimate of health risks for the well field and each of the source areas of the site. The risk assessment was conducted in a manner consistent with U.S. EPA risk assessment guidelines and guidance.

An ecological risk assessment was not performed because the major exposure pathways affected the well field and surrounding industrial areas.

A. Identification of Contaminants of Concern

Seventy three chemicals on the U.S. EPA's Target Compound List (TCL) and Target Analyte List (TAL) were detected during the RI at the Verona Well Field site. Of these 73 chemicals, 48 chemicals were determined to be chemicals of potential concern for the site based on the frequency of detection, and the availability of toxicity data established by U.S. EPA for the chemical. Table 6 lists the 48 chemicals of potential concern for the site. These compounds were used to evaluate toxicity, exposure pathways, and potential health risks for the well field and each of the source areas of the site.

B. Exposure Assessment

Contaminants have been detected in on-site near and subsurface soils at all three source areas. Receptors coming into contact with contaminated subsurface soils may become exposed via three primary pathways: incidental ingestion; dermal contact; and/or inhalation of vapors. Because the major land use for the three source areas at the site are commercial, the exposure scenario was considered to be that of short-term exposure during site excavations and trenching. Therefore, potential receptors due to on-site subsurface soils are on-site short-term workers.

Contaminants have also been detected in groundwater at the source areas and downgradient from the source areas. Human exposure to groundwater contaminants may occur through ingestion of drinking water, by dermal contact with contaminated water, or by inhaling contaminants volatilized from water during showering, cooking, or other household water usage. Currently, all known downgradient receptors are connected to the Battle Creek city water supply. However, exposure may occur through use of private wells for consumption in place of the city-supply water, or through nonconsumptive uses such as gardening or car washing. Figure 16 illustrates exposure pathways for the Verona Well Field site.

To estimate contaminant intake by exposed populations, the risk assessment made certain assumptions about exposure. These

Table 6 (continued)

	ANNEX			PAINT SHOP			RAYMOND ROAD			
	Subsurface	Groundwater		Subsurface	Groundwater		Subsurface	Groundwater		
	Soils	Onsite	Downgradient	Soils	Upgradient	Onsite	Soils	Upgradient	Onsite	Downgradient
Noncarcinogenic (continued)										
Nickel	X	X		X		X				X
Nitrobenzene		X								
Phenol		X				X				
Toluene	X	X	X	X	X	X	X	X	X	X
Trans-1,2-Dichloroethene	X	X	X		X	X	X	X	X	X
1,1,1-Trichloroethane	X	X	X	X	X	X	X		X	X
Tetrahydrofuran							X			
Vanadium	X	X		X		X				X
Xylenes	X	X	X			X	X		X	X
Zinc	X	X		X		X				X
Both Carcinogenic & Noncarcinogenic										
Arsenic				X		X				X
Beryllium	X			X		X				X
Bis(2-ethylhexyl)phthalate	X	X	X	X	X	X	X	X		X
Bromodichloromethane							X			
Carbon Tetrachloride						X	X			
Chloroform	X	X		X		X	X			X
1,1-Dichloroethane		X	X			X	X	X		X
1,1-Dichloroethene		X	X			X	X			X
Hexachloroethane		X								
Methylene Chloride	X	X	X	X	X	X	X	X	X	X
Tetrachloroethene	X	X	X	X	X	X	X	X	X	X
1,1,2-Trichloroethane		X			X	X				X

assumptions address the receptor, exposure route, medium, intake rate, and frequency of exposure via identified pathways. Table 7 lists the exposure assumptions for the Verona Well Field risk assessment.

Contaminant intake estimates were derived using exposure point concentrations, or direct measurements of concentrations at the point of contact. Reasonable maximum exposure estimates were assumed to be the 95 percent upper confidence limit (UCL) of the arithmetic mean concentrations in a given medium at a given source area. For carcinogens, a given total dose is assumed to have similar potency whether exposure occurs over a shorter (40 year) or longer (70 year) period. Exposure to workers is not continuous over a lifetime, so exposures over 40 years were averaged over a lifetime to estimate the average daily intake. For noncarcinogens, daily contaminant intakes are estimated. The estimated intakes for the Verona Well Field site chemicals are compared to lifetime intakes considered by U.S. EPA to be without adverse effect.

Data used in the risk assessment were grouped by source area, medium of concern, and exposure situations. These groupings allow for estimation of potential risk under current and future land use settings.

C. Toxicity Assessment

Carcinogens are characterized by a dose-response relationship that assumes no threshold for exposure without risk. The dose-response relationship for carcinogens is expressed as a carcinogenic slope factor, which converts estimated daily intakes directly to incremental lifetime risk of cancer occurrence. Cancer slope factors (CSFs) have been developed by U.S. EPA's Carcinogenic Assessment Group for estimating cancer risks associated with exposure to potentially carcinogenic chemicals. CSF's, which are expressed in units of $(mg/kg\text{-}day)^{-1}$, are multiplied by the estimated intake of a potential carcinogen in mg/kg-day, to provide an estimate of the excess lifetime cancer risk associated with exposure at that intake level. The CSFs for the carcinogens found at the Verona Well Field and their respective carcinogen classifications are listed in Table 8.

Noncarcinogens are assumed to display a threshold value that exposure must exceed before toxic effects are manifested. The threshold value is used by U.S. EPA to derive the toxicity value which is called the reference dose (RfD). An RfD, expressed in mg/kg/day, is an estimate of an exposure level that would not be expected to cause adverse health effects when exposure occurs over a lifetime. RfDs are designed to protect sensitive individuals and are specific to exposure route. The RfDs for noncarcinogens found at the Verona Well Field are listed in Table 9.

Table 8 (page 1 of 2)
CARCINOGENIC SLOPE FACTORS FOR THE VERONA WELL FIELD CONTAMINANTS OF POTENTIAL CONCERN

	Oral Route				Inhalation Routes			
Chemical	Weight of Evidence[a]	Slope Factor[b] (mg/kg-day)$^{-1}$	Source[c]	Date	Weight of Evidence[a]	Slope Factor[b] (mg/kg-day)$^{-1}$	Source[c]	Date
Arsenic	A	2	HEAST[d]	---	A	50	IRIS	10-1-89
Benzene	A	0.029	IRIS	12-1-88	A	0.029	IRIS	12-1-88
Beryllium	B2	4.3	IRIS	1-1-90	B2	8.4	IRIS	1-1-90
bis(2-Ethylhexyl)phthalate	B2	0.014	IRIS	8-1-89	B2	--	IRIS	8-1-89
Bromodichloromethane	B2	0.13	HEAST	7-1-89	B2	--	HEAST	7-1-89
Carbon tetrachloride	B2	0.13	IRIS	12-1-89	B2	0.13	IRIS	12-1-89
Chloroform	B2	0.0061	IRIS	6-30-88	B2	0.081	IRIS	6-30-88
1,1-Dichloroethane	B2	0.091	HEAST	7-1-89	-	--	-	-
1,2-Dichloroethane	B2	0.091	IRIS	8-1-89	B2	0.091	IRIS	8-1-89
1,1-Dichloroethene	C	0.6	IRIS	4-1-89	C	1.2	IRIS	4-1-89
Hexachloroethane	C	0.014	IRIS	3-1-88	C	0.014	IRIS	3-1-88
Methylene chloride	B2	0.0075	IRIS	10-1-89	B2	0.014	IRIS	10-1-89
N-Nitroso-dipropylamine	B2	7	IRIS	3-1-88	--	--	--	--
Tetrachloroethene	B2	0.051	HEAST	7-1-89	B2	0.0033	HEAST	7-1-89
1,1,2-Trichloroethane	C	0.057	IRIS	9-26-88	C	0.057	IRIS	9-26-88

(con't.)

Table 9 (page 1 of 4)
TOXICITY VALUES FOR NONCARCINOGENS AT VERONA WELL FIELD

Chemical	Reference Dose (RfD) mg/kg/day	Source[a]	Date	Critical Effect	UF[b]	MF[c]	Confidence in RfD[d]
ORAL ROUTE							
Acetone	0.1	IRIS	7-1-89	Increased liver and kidney weight and nephrotoxicity	1,000	1	Low
Antimony	0.0004	IRIS	8-1-89	Longevity, blood glucose, and cholesterol	1,000	1	Low
Arsenic	0.001[e]	HEAST	7-1-89	Keratosis and hyperpigmentation	--	--	--
Barium	0.05	IRIS	8-1-89	Increased blood pressure	100	1	Medium
Benzoic acid	4.0	IRIS	8-1-89	Human daily per capita	1	1	Medium
Beryllium	0.005	IRIS	1-1-90	No adverse effects	100	1	Low
bis(2-Ethylhexyl)phthalate	0.02	IRIS	8-1-89	Increased relative liver weight	1,000	1	Medium
Bromodichloromethane	0.02	IRIS	1-1-89	Renal cytomegaly	1,000	1	Medium
Bromomethane	0.0014	IRIS	8-1-89	Epithelial hyperplasia of forestomach	1,000	1	Medium
2-Butanone	0.05	IRIS	12-1-89	Fetotoxicity in rats	1,000	1	Medium
Butyl benzyl phthalate	0.2	IRIS	9-1-89	Effects on liver:body and liver:brain weight ratios	1,000	1	Low
Cadmium	0.0005	IRIS	10-1-89	Significant proteinuria	10	1	High
Carbon disulfide	0.1	IRIS	2-1-89	Fetal toxicity/malformations	100	1	Medium
Carbon tetrachloride	0.0007	IRIS	12-1-89	Liver lesions	1,000	1	Medium
Chlorobenzene	0.02	HEAST	7-1-89	Liver and kidney effects	1,000	--	--
Chloroform	0.01	IRIS	6-30-88	Fatty cyst formation in liver	1,000	1	Medium

Table 9 (page 3 of 4)
TOXICITY VALUES FOR NONCARCINOGENS AT VERONA WELL FIELD

Chemical	Reference Dose (RfD) mg/kg/day	Source[a]	Date	Critical Effect	UF[b]	MF[c]	Confidence in RfD[d]
ORAL ROUTE (continued)							
2-Methylphenol	0.05	IRIS	11-1-89	Decreased body weights and neurotoxicity	1,000	1	Medium
4-Methylphenol	0.05	IRIS	11-1-89	Decreased body weights and neurotoxicity	1,000	1	Medium
Naphthalene	0.4[e]	HEAST	7-1-89	Ocular and internal lesions	100	--	--
Nickel	0.02[g]	IRIS	3-1-88	Decreased body and organ weights	100	3	Medium
Nitrobenzene	0.0005	IRIS	8-1-89	Hematologic, adrenal, renal and hepatic lesions	10,000	1	Low
Phenol	0.6	IRIS	10-1-89	Reduced fetal body weight in rats	100	1	Low
Tetrachloroethene	0.01	IRIS	7-1-89	Hepatotoxicity in mice, weight gain in rats	1,000	1	Medium
Toluene	0.3	IRIS	7-1-89	Clinical chemistry and hematological parameters	100	1	Medium
1,1,1-Trichloroethane	0.09	IRIS	6-1-89	Slight growth retardation guinea pigs	1,000	1	Medium
1,1,2-Trichloroethane	0.004	IRIS	9-26-88	Clinical serum chemistry	1,000	1	Medium
Vanadium	0.007	HEAST	7-1-89	None observed	100	--	--
Xylenes	2.0	IRIS	7-1-89	Hyperactivity, decreased body weight and increased mortality (males)	100	1	Medium
Zinc	0.2	HEAST	7-1-89	Anemia	10	--	--

D. Risk Characterization

In order to determine risk, toxicity information for each chemical is compared to the contaminant exposure levels measured at the site. Following the determination of risks for individual chemicals, cumulative risks are estimated by adding the individual risks for the particular chemicals effecting a given pathway. The result is a total risk estimate for that pathway of exposure to a particular medium. For carcinogens, the result is the excess lifetime cancer risk for the pathway. For noncarcinogens, this results in a hazardous index (HI) for the pathway.

The current and/or future areas of potential risk are listed below. These areas were calculated to have chemicals present with hazard index values greater than one for noncarcinogens and/or excess lifetime cancer risks of greater than 1×10^{-6} for carcinogens. The U.S. EPA considers excess lifetime cancer risks in a range of 10^{-4} to 10^{-6} as protective; however, the 10^{-6} risk level is used as a point of departure for setting clean-up levels at Superfund sites.

* Current residential (nonconsumptive) uses of groundwater downgradient of Thomas Solvent Raymond Road

* Current residential (consumptive) uses of groundwater downgradient of Thomas Solvent Annex

* Future trench workers at any of the three source areas (inhalation)

* Future residents downgradient of and trench workers at any of the three source areas (ingestion and dermal exposure to groundwater)

Tables 10 through 15 summarize the cumulative risks for carcinogens and noncarcinogens for each of the affected pathways identified at the Verona Well Field site. A 1×10^{-6} excess lifetime cancer risk is considered appropriate for setting clean up goals at this site considering the groundwater is currently used for drinking water and is the sole source of drinking water for the City of Battle Creek.

VII. DESCRIPTION OF ALTERNATIVES

A. Response Objectives

Following completion of the baseline risk assessment, site-specific remedial action goals were developed. These goals, listed below,

Table 12 Summary of Risk Estimates from Subsurface Soils: Ingestion and Inhalation by Trench Worker				
Site	**Exposure Scenario**	**Noncarcinogenic Hazard Index**	**Excess Lifetime Cancer Risk**	
		Ingestion	**Ingestion**	**Inhalation**
Annex	Trench Worker	0.39	3×10^{-7}	7×10^{-4}
Paint Shop	Trench Worker	<0.01	8×10^{-10}	3×10^{-6}
Raymond Road	Trench Worker	<0.01	3×10^{-9}	2×10^{-5}

Table 13 Summary of Risk Estimates from Onsite Groundwater in the Raymond Road Area					
Site	**Exposure Scenario**	**Noncarcinogenic Hazard Index**		**Excess Lifetime Cancer Risk**	
		Ingestion	**Dermal**	**Ingestion**	**Dermal**
Raymond Road Onsite	Future Resident	13.4	0.02	7×10^{-3}	1×10^{-5}
Raymond Road Onsite	Future Worker	6.72	<0.01	1×10^{-3}	1×10^{-6}

are based on the general goals of the Superfund program as defined in CERCLA and the NCP.

* 1A-Limit groundwater contamination at the Verona Well Field production wells to contaminant levels that meet State and Federal clean up standards for protecting human health and the environment;

* 1B-Reduce groundwater contamination in the entire aquifer to contaminant levels that meet State and Federal clean up standards for protecting human health and the environment;

* 2A-Reduce all soil contamination at the major source areas to levels with a hazard index of less than or equal to one for noncarcinogens and a total excess cancer risk 1×10^{-6} or less for carcinogens.

* 2B-Reduce all soil contamination at the major source areas to levels that will prevent groundwater at the site from exceeding the State and Federal clean up standards for groundwater.

Site-specific clean up goals were also determined for soils and groundwater based on the results of the risk assessment and Federal and State Applicable or Relevant and Appropriate Requirements (ARARs). Groundwater and soil clean up goals are listed in Tables 16 and 17 respectively. The site-specific remedial action goals and clean up goals were the basis for developing, screening and evaluating alternatives in the feasibility study for the final operable unit at the site.

It should be noted that the Cleanup goals listed in Tables 16 and 17 have been updated since issuance of the FS. This is because several factors used in determining the cleanup goals have changed since that time. First, based on new guidance for performing risk assessments (OSWER Directive 9285.6-03), the assumptions used to evaluate lifetime exposure have changed from 70 years to 40 years and from 365 to 350 days per year. Second, cleanup numbers under Michigan's Act 307 have been revised based on the change in lifetime exposure assumptions (discussed above) and on new toxicologic data developed. Third, cleanup numbers have been adjusted to be at least equivalent to the lowest acceptable method detection limits available.

B. <u>Development of Alternatives</u>

Alternatives developed in the feasibility study for the final operable unit considered the Annex and Marshalling Yard Paint Shop source areas and groundwater downgradient of the sources and in the well field. Additional remedial measures for the Thomas Solvent Raymond Road source area are evaluated in a separate document

TABLE 17

Verona Well Field, Battle Creek, Michigan Revised Soil Cleanup Objectives (6/12/91)						
		Objective 2A		Objective 2B		
Contaminant	Soil MDL[5]	Cancer Risk Goal (Carcinogens)[1]	Risk-Ratio Goal (Noncarcinogens)[2]	TCLP Estimate for Groundwater Protection[3]	Michigan Act 307[4]	Cleanup Objective
Benzene	10	73,000	--	60	20	20
Carbon Tetrachloride	10	16,000	490,000	13	6	10
1,1-Dichloroethane	10	23,000	70,000,000	20	10,000	20
1,1-Dichloroethene	10	4,000	6,300,000	4	100	10
1,2-Dichloroethane	10	23,000	--	20	8	10
1,2-Dichloroethene (cis)	10	--	--	20	20	20
1,2-Dichlorethene (trans)	10	--	14,000,000	2,000	2,000	2,000
Ethylbenzene	10	--	70,000,000	14,000	1,400	1,400
Methylene Chloride	10	283,000	42,000,000	220	100	100
Tetrachloroethene	10	43,000	7,000,000	40	10	10
Toluene	10	--	210,000,000	20,000	16,000	16,000
1,1,1-Trichloroethane	10	--	63,000,000	4,000	4,000	4,000
Trichloroethene	10	195,000	--	160	60	60
Xylenes	10	--	1,400,000,000	200,000	6,000	6,000

[1]Carcinogenic concentration refers to soil concentration associated with a 1×10^{-6} excess lifetime carcinogenic risk, based on residential ingestion exposure assumptions (0.1 g/d, 350 d/yr, 24 yrs, 70 kg adult).
[2]Noncarcinogenic concentration refers to soil concentration associated with an acceptable daily exposure to a specific contaminant, based on residential ingestion exposure assumptions.
[3]Concentrations in soil that would be expected to leach into the groundwater at concentrations greater than the groundwater goals based on U.S. EPA TCLP procedures (40CFR261).
[4]Concentrations in soil that would be expected to leach into the groundwater at concentrations greater than Michigan Act 307 groundwater cleanup limits.
[5]Acceptable Method Detection Limits (MDNR, April 1991).
Note: Concentrations are in µg/kg
-- indicates that no value is available
In lieu of meeting soil cleanup numbers, a leachate test may be performed as specified in Section 6 of Michigan Act 307 for Type B soil cleanups.

titled, Performance Evaluation Report [of] Thomas Solvent Raymond Road Operable Unit, Verona Well Field Site, Battle Creek, Michigan. The findings presented in this document are discussed in Section IX of this ROD.

Remedial alternatives were assembled from applicable remedial technology process options and were initially screened for effectiveness, implementability, and cost. Alternatives surviving the initial screening were evaluated and compared with respect to the nine criteria required by the NCP. In addition to the remedial action alternatives, the NCP requires that a no-action alternative also be considered for the site. The no-action alternative serves primarily as a point of comparison for other alternatives.

In developing alternatives, the FS takes into consideration that previous remedial and removal actions have occurred or are currently taking place and will continue to operate. The FS also makes assumptions regarding groundwater usage by the City of Battle Creek. For the purpose of evaluating alternatives, 80 percent of the City's 1989 maximum daily pumping rate was used. This was considered a reasonable estimate for the average pumping rate in the well field. No provision was made for increase in capacity due to future growth in evaluating effectiveness of the alternatives. It is U.S. EPA's policy not to provide for future growth in designing remedial actions at Superfund sites.

Due to the complex hydrogeology of the Verona Well Field, a groundwater flow model coupled with particle tracking was developed and used to evaluate groundwater alternatives. The model allowed for evaluation of hydrogeologic conditions and flow characteristics for each alternative. Particle tracking was used to define capture zones and estimate contaminant travel times under different pumping scenarios.

Groundwater modeling of the no-action alternative indicates that the current blocking-well system may not provide complete protection to the well field in the future. Simulated groundwater flow in the aquifer using pumping rates for 1989, indicate a component of flow toward the Battle Creek River that could cause contaminants to move around the western end of the blocking line to the production wells west of the River, Bailey Park Wells (see Figure 10).

Based on this finding, U.S. EPA's contractor, CH_2M Hill, looked at modifying the current blocking system and adding purge wells south of the existing blocking wells in the vicinity of the southern boundary of the well field. Based on a comparison of the two options, additional purge wells were determined to be more protective, easier to implement, and more cost-effective. As a result of this evaluation, the FS assumed that additional purge wells downgradient of the sources and south of the existing blocking wells in the well field will be installed under all alternatives except the no-action alternative.

All of the alternatives include groundwater monitoring during the remediation to measure progress and performance, and to verify compliance with cleanup goals and discharge limits. Actual monitoring points, duration of the monitoring program, and analytical parameters will be determined by U.S. EPA, in consultation with the State, during the remedial design. Table 18 provides a summary of the various components of each of the alternatives.

C. Alternatives

Alternative 1 - No Action

Under Alternative 1 no additional corrective action would be taken at the site. The no-action alternative would include continued operation of the soil and groundwater remediation at the Thomas Solvent Raymond Road facility and existing blocking wells and air stripper in the well field as well. Operation and maintenance would include periodic replacement of pumps, blowers, and packing in the air stripper as well as system monitoring and purge well maintenance (e.g., acid cleaning and pump tests).

As discussed above, the existing blocking-well system may not protect the western portion of well field in the future. Figure 10 illustrates projected groundwater flow in the aquifer for the no action alternative. As shown, there is a component of flow that could travel around the western end of the current blocking wells and contaminate the Bailey Park Wells.

Since no action would be taken at the Annex and Marshalling Yard Paint Shop source areas, contamination of groundwater would continue. There would be no aquifer restoration at the source areas and it is therefore assumed that the blocking wells would have to operate indefinitely. Costs for this alternative would result from the operation and maintenance of the existing groundwater extraction system. It is estimated that operation and maintenance costs per year would be approximately $160,000, with a 30 year present worth of $2,500,000.

Alternative 1 does not meet a number of Federal and State ARARS. Specifically, it would not meet Federal Maximum Contaminant Levels (MCLs) and Michigan Act 307 Rules.

Alternative 2 - Additional Purge-Well System

Alternative 2 consists of the present blocking wells plus additional purge wells to the south of the well field, downgradient of the source areas. The FS estimated the need for 8 additional wells with a total pumping rate of 1000 gallons per minute (gpm).

As discussed above, the addition of extraction wells to the south of the existing blocking wells would prevent contamination from bypassing the existing blocking wells and reaching the Bailey Park Wells. Additional extraction wells would also provide added protection to the entire well field and would result in a greater portion of the aquifer being cleaned up more quickly between the sources and the existing blocking wells.

Extracted groundwater would be treated utilizing an air stripper with vapor phase carbon for treatment of emissions. The design of the stripper would be required to meet the technical requirements of Michigan's surface water and air discharge standards. Operation and Maintenance of the treatment systems would include routine maintenance of the pumps, fans, and electrical systems and replacement of the packing and parts. Long-term groundwater monitoring would also be required for influent and effluent of the air stripper and the individual extraction wells.

Since no action would be taken at the Annex or Marshalling Yard Paint Shop source areas, contamination of groundwater would continue. There would be no aquifer restoration at the source areas and it is therefore assumed that the new purge wells would have to operate indefinitely. Costs for this alternative would result from the operation and maintenance of the existing blocking wells and the new purge wells. It is estimated that Alternative 2 would have a capital cost of $1,400,000. Operation and maintenance costs per year would be approximately $410,000, with a 30 year present worth of $6,600,000.

All ARARs relating to the removal and treatment of contaminated groundwater would be met. All spent carbon generated by the treatment process would undergo regeneration at a RCRA compliant facility. Air and Water Discharge standards would also be met by the treatment process and flood plain protection would be incorporated into siting of equipment. However, contaminants in soils and groundwater at the source areas would violate Federal MCLs and Michigan Act 307 Rules.

Alternative 3 - Groundwater Collection and Treatment

Alternative 3 consists of groundwater collection and treatment at the Annex and Marshalling Yard Paint Shop source areas, and implementation of Alternative 2, the additional purge wells. The FS estimated the need for six extraction wells pumping at a total of 400 gpm at the Annex, and four extraction wells pumping at a total of 400 gpm at the Marshalling Yard Paint Shop.

Groundwater modeling was used to predict flow directions and capture zones of the proposed extraction well systems for the Annex and Marshalling Yard Paint Shop (see Figures 17 and 18). The

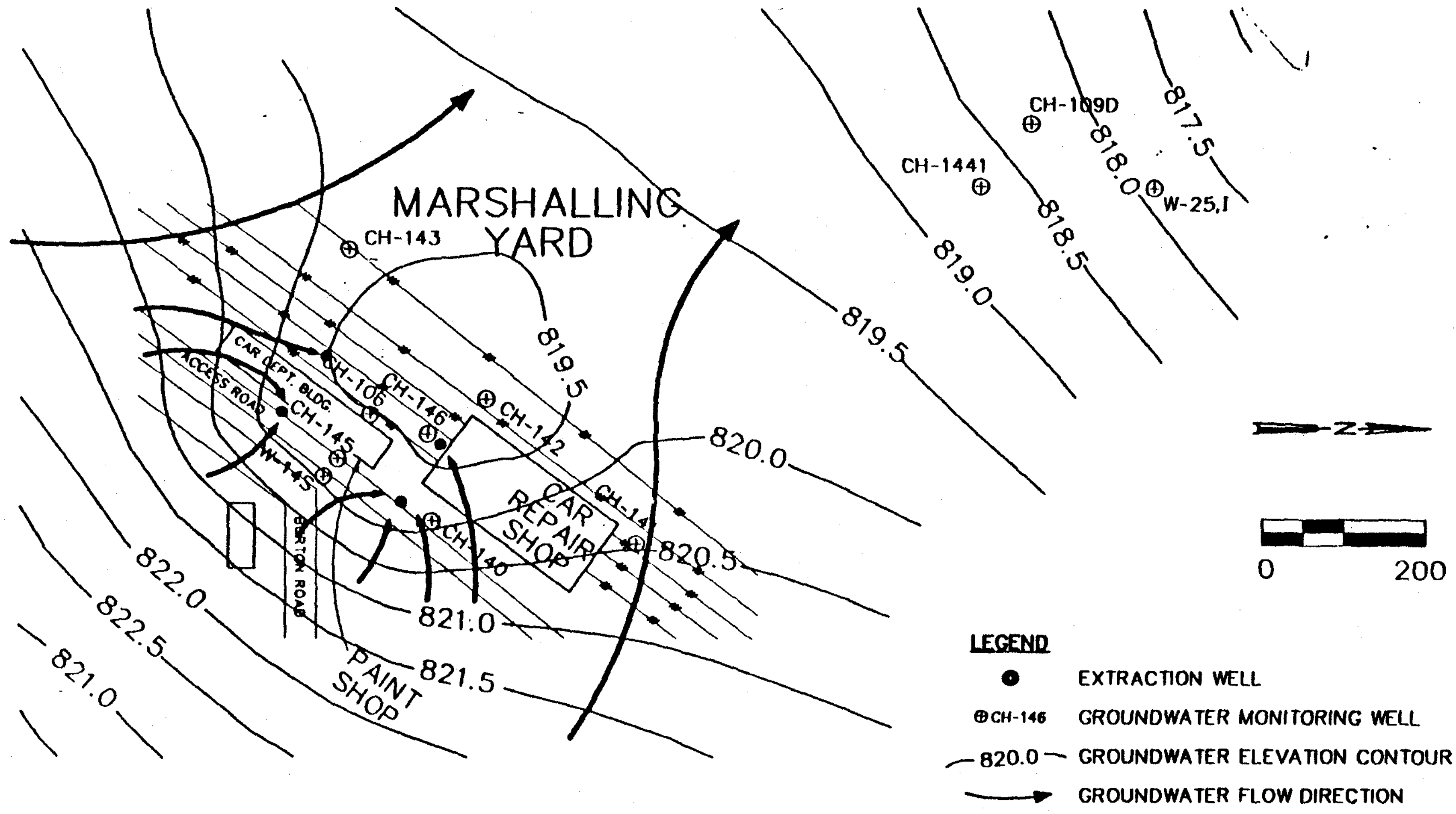


FIGURE 18
GROUNDWATER SURFACE AND FLOW DIRECTIONS IN PAINT SHOP AREA
ALTERNATIVE 3

VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

capture zone for the Annex groundwater extraction system is estimated to extend 1000 feet laterally and 400 feet downgradient. At the Marshalling Yard Paint Shop, the capture zone would extend 800 feet laterally and 400 feet downgradient. Contamination greater than 400 feet downgradient of the source areas would migrate to the new purge wells proposed as part of Alternative 2.

Extracted groundwater would be treated utilizing air stripping with vapor phase carbon for treatment of emissions. The design of the air stripper(s) would need to meet the technical requirements of Michigan's surface and air discharge standards. Operation and maintenance of the treatment systems would include routine maintenance of the pumps, fans, and electrical systems and replacement of the air stripper packing and parts. Long-term groundwater monitoring would also be required for influent and effluent of the air stripper and the individual extraction wells.

Although contaminants in groundwater at the source areas would be captured, this alternative does not include remediation of the source area soils which would result in indefinite loading of contaminants to groundwater. Therefore, the groundwater systems at the sources would likely need to operate for more than 50 years. Downgradient contamination would migrate to the new purge wells and would result in clean up of the downgradient portion of the aquifer. The existing blocking wells would also be operational and would result in removal of contamination between the blocking wells and new purge wells. It is estimated that the aquifer downgradient of the sources would achieve clean up goals in approximately 20 years.

Alternative 3 would attain ARARs relating to the removal and treatment of contaminated groundwater. In addition, Federal and State chemical-specific ARARs would eventually be met for groundwater. All spent carbon generated by the treatment process would be regenerated at a RCRA compliant facility. Air and Water Discharge standards would also be met by the treatment process and flood plain protection would be incorporated into siting of equipment. However, the lack of soil treatment at the source areas would violate requirements of Michigan Act 307 Rules for Type B cleanups.

Costs for this alternative would result from the operation and maintenance of the existing blocking wells, the additional purge wells and source area groundwater extraction systems. It is estimated that Alternative 3 would have a capital cost of $3,900,000. Operation and maintenance costs per year would be approximately $590,000, with a 30 year present worth of $11,700,000.

Alternative 4 - In Situ Soil Treatment

Alternative 4 includes soil vapor extraction (SVE) systems at the

Annex and Paint Shop source areas to remove contaminants from the unsaturated soils. The SVE system would be designed to treat all contaminated soil at the Annex and the Paint Shop (currently estimated to be 26,000 and 4,000 cubic yards respectively.

The FS estimated the need for 18 SVE wells and 9 air injection wells at the Annex with a total flow rate of approximately 2,200 scfm (standard cubic feet per minute), and 4 SVE wells at the Paint Shop with a total flow of 400 scfm. The conceptual layout of the systems at the Annex and Paint Shop are presented in Figures 19 and 20 respectively. Treatment of off-gases from the SVE systems will be required prior to discharge and must meet MDNR air permit requirements.

No groundwater treatment at the source areas is included with this alternative, but Alternative 2, the additional purge wells, would be included. Because groundwater at the source areas would not be extracted and treated, cleanup times for the aquifer between the source areas and the downgradient purge wells is expected to be greater than 50 years. The length of time for operation of the SVE systems in order to meet soil clean up goals is estimated to be between 2 and 5 years.

Soil treatment to clean up goals would meet the requirements of Michigan's Act 307 Rules for soil remediation. Treatment of vapors would comply with Federal and State requirements for air emissions, and the system could be designed and managed to meet all action and location specific ARARs. Since this alternative does not include groundwater extraction at the source areas, it is unlikely that Federal MCLs or groundwater requirements of Michigan Act 307 would be met for sometime.

Costs for this alternative would result from the operation and maintenance of the existing blocking wells, the additional purge wells and source area SVE systems. It is estimated that Alternative 4 would have a capital cost of $3,500,000. Operation and maintenance costs per year would be approximately $620,000, with a present worth of $9,300,000.

Alternative 5 - Soil Excavation and Thermal Treatment

Alternative 5 consists of excavation and on-site incineration of the contaminated soils at the Annex and Paint Shop source areas. The volume of contaminated soils is estimated to be 26,000 cubic yards at the Annex, and 4,000 cubic yards at the Paint Shop.

Because of the lack of space at the Paint Shop, the FS assumed that the incinerator would be placed at the Annex. Soil from the Paint Shop would be transported to the Annex for treatment. A conceptual layout of the incinerator and soil storage area is presented in Figure 21. Much of the soils to be remediated at the Paint Shop are presently underneath the existing Car Department building.

and new purge wells. It is estimated that the aquifer downgradient of the sources would achieve clean up goals in approximately 20 years.

Alternative 6 would meet all Federal and State chemical-specific ARARs for soils and groundwater. The treatment systems could be designed to meet all location- and action-specific ARARs as well.

Costs for this alternative would result from the implementation, operation and maintenance of the existing blocking wells, the additional purge wells, source area groundwater collection and treatment, and source area SVE. It is estimated that Alternative 6 would have a capital cost of $6,200,000. Operation and maintenance costs per year would be approximately $840,000, with a present worth of $15,300,000.

Alternative 7 - Groundwater Treatment and Soil Incineration

Alternative 7 is a combination of Alternatives 2, 3, and 5. This includes continued operation of the existing blocking wells, installation of additional purge wells downgradient of the source areas, groundwater collection and treatment at the source areas, and excavation and incineration of source area soils.

As with Alternative 6, removing vadose zone contamination would limit contaminant migration from soils to groundwater, and active groundwater collection at the sources would greatly reduce contaminant plume concentrations at the sources. The FS estimated that soil clean up goals could be achieved in less than one year. It is estimated that the aquifer downgradient of the sources would achieve clean up goals in approximately 20 years.

Alternative 7 would meet all Federal and State chemical-specific ARARs for soils and groundwater. The treatment systems could be designed to meet all location- and action-specific ARARs as well. Because it is a RCRA waste, the incinerator ash would be delisted prior to being placed back onsite.

Costs for this alternative would result from the implementation, operation and maintenance of the existing blocking wells, the additional purge wells, source area groundwater collection and treatment, and excavation and incineration of source area soils. It is estimated that Alternative 7 would have a capital cost of $22,000,000. Operation and maintenance costs per year would be approximately $720,000, with a present worth of $31,100,000.

Alternative 8 - In Situ Groundwater and Soil Treatment

Alternative 8 includes the downgradient purge wells of Alternative 2, the source area groundwater collection and treatment systems of Alternative 3, the source area SVE systems of Alternative 4 and in situ biological treatment (bioremediation) of contaminants in the

NOTES - TABLES 1 - 5

Notes:

J = Result below contract-required detection limit; reported as an estimate
B = Result also found in corresponding blank sample
D = Dilution sample
E = Estimated, value was above calibration range
Blanks = Compound was not detected

Example column head:

Head	Definition
GWB19-01	Sample number
EAW000	EPA ID number
02/28/89	Date sample taken
GRAB	Sample type

Key to sample number:
GW = Groundwater
B19 = Well number
Numbers after hyphen (-01) = Sampling round

Tabl

GROUNDWATER ANALYTICAL RESULTS FROM THOMAS SOLVENT RAYMOND ROAD ONSITE WELLS (ppb)

Compound	GWB19-01 EAW00 02/28/89 GRAB	GWB20-01 EAW01 02/28/89 GRAB	GWB21-01 EAW81 02/28/89 GRAB	GWCH127S-01 EAW51 03/01/89 GRAB	GWB17-02 EAL94 04/04/98 GRAB	GWB18-02 EAL95 04/04/89 GRAB	GWB19-02 EAL96 04/03/89 GRAB	GWB20-02 EAL97 04/03/89 GRAB
Chloromethane								
Bromomethane								
Vinyl Chloride								
Chloroethane								
Methylene Chloride	2		6 J					
Acetone			45			1300		
Carbon Disulfide								
1,1-Dichloroethene								
1,1-Dichloroethane								
1,2-Dichloroethene								
Chloroform								
1,2-Dichloroethane								
2-Butanone								
1,1,1-Trichloroethane		3	23			6900	1	4
Carbon Tetrachloride								
Vinyl Acetate								
Bromodichloromethane								
1,2-Dichloroporpane								
cis-1,2-Dichloropropene								
Trichloroethene	2	6	55			17000	3	6
Dibromochloromethane								
1,1,2-Trichloroethane								
Benzene			5 J			360		
trans-1,3-Dichloropropene								
Bromoform								
4-Methyl-2-Pentanone								
2-Hexanone								
Tetrachloroethene	8	19	360			17000	10	26
1,1,2,2-Tetrachloroethane								
Toluene						34000	0.6	
Chlorobenzene								
Ethylbenzene						2000		
Styrene								
Total Xylenes						7400		
Acrolein								
Acrylonitrile								
TOTAL VOCs	12	28	494	0	0	85960	14.6	36

Concentrations are μg/l

TABLE 2 (CONTINUED)
ANNEX SOIL BORING ANALYTICAL RESULTS (µg/kg)
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

SOIL BORING	INTERVAL (FT)	LOCATION	DCA	DCE	TCA	TCE	PCA	PCE	TOL	XYL	ED	MECL	2-BUT	ACE	TOTAL VOCS
SB-07	0-6	Transfer	...	...	...	...	...	710	...	...	...	...	...	...	710
	6-12		...	370	...	1700	...	7000	150	650	180	...	...	...	10050
	12-14		...	570	...	...	...	900	...	...	...	...	...	...	1470
SB-08	0-6	Turn-Around	...	...	...	390	...	16000	...	...	...	...	...	...	16390
	6-12		...	...	...	...	...	2300	...	...	...	...	...	...	2300
	12-14		...	...	...	...	...	8400	...	...	...	...	...	...	8400
SB-09	0-6	Turn-Around	...	...	...	...	...	29000	...	...	...	...	...	...	29000
	6-12		...	...	...	160	...	3000	...	...	...	...	...	...	3160
	12-14		...	...	...	730	...	2000	...	...	...	...	...	...	2730
SB-10	0-6	Turn-Around	...	...	...	280	...	1900	...	...	...	...	...	...	2180
	6-12		...	...	...	...	...	16000	...	...	...	...	...	...	16000
	12-16		...	...	...	4200	...	12000	2500	3200	13000	...	...	...	34900
SB-11	0-6	Turn-Around	...	...	210	2100	...	5400	...	...	...	...	...	...	7710
	6-12		...	150	990	2600	...	1200000	...	380	...	...	...	...	1204120
	12-16		...	2700	1800000	4600000	...	42000000	3400000	12000000	1500000	...	...	840	65303540
SB-12	0-6	Tank Area	...	...	...	...	...	...	...	...	...	...	...	...	0
	6-12		...	...	...	...	...	370	...	...	...	...	...	...	370
	12-14		...	...	...	...	...	1200	...	...	...	...	...	...	1200
SB-13	0-6	Turn-Around	...	...	...	160	...	930	...	...	...	...	...	...	1090
	6-12		...	...	...	...	...	2000	...	...	...	...	...	...	2000
	12-14		...	...	...	...	...	1200	...	...	...	...	...	...	1200
SB-14	0-6	Turn-Around	...	...	...	260	...	970	...	...	...	...	...	...	1230
	6-12		...	...	...	...	...	870	...	...	...	...	...	...	870
	12-16		...	...	...	...	...	1900	230	...	...	...	...	...	2130
SB-15	0-6	Transfer	...	...	...	1000	...	5900	3900	...	...	...	...	...	10800
	6-12		...	...	...	1400	...	5400	1300	380	...	...	...	...	8480
	12-14		...	...	...	190	...	2800	1700	...	...	...	...	...	4690
SB-16	0-6	Dock	...	...	...	390	...	1200	410	...	...	...	...	440	2440
	6-12		...	...	...	...	...	200	140	...	...	...	...	...	340
	12-16		...	...	...	...	...	140	160	...	...	...	...	...	300

Compounds

DCA- 1,2 DICHLOROETHANE
DCE- 1,2 DICHLOROETHENE
TCA- TRICHLOROETHANE
TET- TRICHLOROETHENE
PCE- 1,1,2,2 TETRACHLOROETHANE
TOL- TOLUENE
XYL- XYLENE
ED- ETHYLBENZENE
MECL- METHYLENE CHLORIDE
2-BUT- 2-BUTANONE
ACE- ACETONE
... BELOW CONTRACT REQUIRED DETECTION LIMITS

Locations

DOCK- LOADING DOCK
TANK AREA- UNDERGROUND TANK/TANK CONTROL AREA
TRANSFER- SOLVENT TRANSFER STATION
TURN-AROUND- TRUCK TURN-AROUND AREA

Table 3

GROUNDWATER ANALYTICAL RESULTS FROM THOMAS SOLVENT ANNEX ONSITE WELLS (ppb)

Compound	GWB08-03 EEE39 06/29/89 GRAB	GWB08-03 EEE93 06/29/89 DUPLICATE	GWB081-03 EEE08 06/29/89 GRAB	GWB09-03 EEE44 06/28/89 GRAB	GWB23-03 EEE47 06/28/89 GRAB	GWB25-03 EEE62 06/28/89 GRAB	GWCH107I-03 EEF74 06/28/89 GRAB	GWCH107D-03 EEF73 06/28/89 GRAB
Chloromethane								
Bromomethane								
Vinyl Chloride							220 J	3
Chloroethane								
Methylene Chloride								
Acetone						2600 J		
Carbon Disulfide								
1,1-Dichloroethene								
1,1-Dichloroethane					8			
1,2-Dichloroethene	13000	11000 D		980	8 D	730 J	1600	18
Chloroform								
1,2-Dichloroethane								
2-Butanone								
1,1,1-Trichloroethane	1200 J	12000			3			
Carbon Tetrachloride								
Vinyl Acetate								
Bromodichloromethane								
1,2-Dichloroporpane								
cis-1,2-Dichloropropene								
Trichloroethene		170			5 D	580 J	110 J	
Dibromochloromethane								
1,1,2-Trichloroethane								
Benzene								
trans-1,3-Dichloropropene								
Bromoform								
4-Methyl-2-Pentanone								
2-Hexanone								
Tetrachloroethene		900		300 J	9 D	3300	240	2
1,1,2,2-Tetrachloroethane								
Toluene	3300	4200 D						
Chlorobenzene								
Ethylbenzene	7100	7900 D						
Styrene								
Total Xylenes	24000	11000 D				1700 J		
Acrolein								
Acrylonitrile								
TOTAL VOCs	48600	47170	0	1280	33	8910	2170	23

Concentrations are µg/l

Table 3

GROUNDWATER ANALYTICAL RESULTS FROM THOMAS SOLVENT ANNEX ONSITE WELLS (ppb)

Compound	GWB08-01 EAW49 03/01/89 GRAB	GWB081-01 EAW50 03/01/89 GRAB	GWB09-01 EAW67 03/02/89 GRAB	GWB23-01 EAW56 03/01/89 GRAB	GWB23-01 EAW57 03/01/89 DUPLICATE	GWB25-01 EAW55 03/01/89 GRAB	GWCH107I-01 EAW72 03/02/89 GRAB	GWCH107D-01 EAW70 03/02/89 GRAB
Chloromethane								
Bromomethane								
Vinyl Chloride				0.7 J			160 D	9 D
Chloroethane								
Methylene Chloride						3	46 D	3 JD
Acetone								6
Carbon Disulfide								
1,1-Dichloroethene			17				12 D	1
1,1-Dichloroethane			62 D	7 D	6	1 J	37 D	4 D
1,2-Dichloroethene			3200 D	180 D	150	31	1500 D	160 D
Chloroform			1					0.5 J
1,2-Dichloroethane			13				4 J	1 J
2-Butanone								
1,1,1-Trichloroethane			62 D	3 DJ	3 J	5	34 D	0.8 J
Carbon Tetrachloride								
Vinyl Acetate								
Bromodichloromethane								
1,2-Dichloroporpane								
cis-1,2-Dichloropropene								
Trichloroethene			170 D	110 D	95	12	150 D	6 D
Dibromochloromethane								
1,1,2-Trichloroethane								0.6 J
Benzene			43	4 DJ	3 J		22 JD	2
trans-1,3-Dichloropropene								
Bromoform								
4-Methyl-2-Pentanone								
2-Hexanone								
Tetrachloroethene	2		340 D	190 D	170	55	310 D	6 D
1,1,2,2-Tetrachloroethane								
Toluene	2		9			11	56 D	3 JD
Chlorobenzene			1					0.4 J
Ethylbenzene	13		140 D	2		0.9 J	84 D	0.8 J
Styrene								
Total Xylenes	34		36			20	160 D	19 D
Acrolein								
Acrylonitrile								
TOTAL VOCs	51	0	4094	496.7	427	138.9	2575	223.1

Concentrations are μg/l

Table 5

GROUNDWATER ANALYTICAL RESULTS FROM THE GRAND TRUNK PAINT SHOP ONSITE WELLS (ppb)

Compound	GWCH106I-01 EAG14 03/05/89 GRAB	GWCH140I-01 EAG09 03/05/89 GRAB	GWCH145I-01 EAG12 03/05/89 GRAB	GWCH146I-01 EAG13 03/05/89 GRAB	GWCH106I-02 EDG82 04/05/89 GRAB	GWCH140I-02 EDG85 04/06/89 GRAB	GWCH145I-02 EDG88 04/06/89 GRAB	GWCH146I-02 EDG81 04/05/89 GRAB
Chloromethane								
Bromomethane								
Vinyl Chloride								
Chloroethane								
Methylene Chloride						1	16	
Acetone								
Carbon Disulfide								0.4
1,1-Dichloroethene		5	560 E			4	99	0.3
1,1-Dichloroethane			59		210	1	33	20.9
1,2-Dichloroethene			19		17000		23	
Chloroform			1					
1,2-Dichloroethane			2					
2-Butanone								
1,1,1-Trichloroethane	0.6 J	150 D	4400 D		1500	87	6300	4.6
Carbon Tetrachloride			180					
Vinyl Acetate								
Bromodichloromethane								
1,2-Dichloroporpane								
cis-1,2-Dichloropropene								
Trichloroethene			36		280		30	0.5
Dibromochloromethane								
1,1,2-Trichloroethane			22					
Benzene		3 J	2		160			10.9
trans-1,3-Dichloropropene								
Bromoform								
4-Methyl-2-Pentanone								
2-Hexanone								
Tetrachloroethene	6	330 D	12000 D		1300	190	16000	23.1
1,1,2,2-Tetrachloroethane								
Toluene					4900			5.5
Chlorobenzene					160			
Ethylbenzene					11000			0.7
Styrene								0.3
Total Xylenes					28000			3.3
Acrolein								
Acrylonitrile								
TOTAL VOCs	6.6	488	17281	0	64510	283	22501	70.5

Concentrations are µg/l

Table 6
CHEMICALS OF POTENTIAL CONCERN DETECTED IN VERONA WELL FIELD AREA

	ANNEX			PAINT SHOP			RAYMOND ROAD			
	Subsurface	Groundwater		Subsurface	Groundwater		Subsurface	Groundwater		
	Soils	Onsite	Downgradient	Soils	Upgradient	Onsite	Soils	Upgradient	Onsite	Downgradient
Carcinogenic										
Benzene		X	X			X	X	X	X	X
1,2-Dichloroethane	X	X	X			X	X			X
n-Nitroso-di-n-propylamine						X				
Trichloroethene	X	X	X			X	X	X	X	X
Vinyl Chloride		X	X			X		X		X
Noncarcinogenic										
Acetone	X	X	X		X	X	X	X	X	X
Antimony							X			X
Barium	X	X		X		X				X
Benzoic Acid						X	X			
Benzylbutylphthalate							X			
Bromomethane							X			
2-Butanone	X						X			
Cadmium						X				X
Carbon Disulfide						X	X		X	X
Chlorobenzene		X	X			X	X			X
Chromium	X	X		X		X				X
Copper	X			X		X				X
Dibutylphthalate							X			
Diethylphthalate		X								
Ethylbenzene	X	X	X	X		X	X		X	X
Manganese	X	X		X		X				X
Mercury (Inorganic)										X
2-Methylphenol		X				X				
4-Methylphenol						X				
4-Methyl-2-Pentanone			X			X	X			X
Naphthalene		X					X			

Table 7
EXPOSURE ASSUMPTIONS FOR THE VERONA WELL FIELD SITE

Receptor	Exposure Route[a]	Medium	Intake Rate	Exposure Frequency[b]
Current resident (nonconsumptive use)	ingestion	water	0.1ℓ/day	12/yr/70 yr
	dermal	water	[c]	12/yr/70 yr
Current resident (consumptive use)	ingestion	water	2ℓ/day	daily/70 yr
	dermal	water	[c]	daily/70 yr
Future resident	ingestion	water	2ℓ/day	daily/70 yr
	dermal	water	[c]	daily/70 yr
Future worker	ingestion	water	1ℓ/day	250 days/yr/40 yr
	dermal	water	[c]	250 days/yr/40 yr
	ingestion	soil	0.1g/day	once/yr/40 yr
	inhalation	vapors	$2.1 m^3/hr$	8 hr/day, once/yr/40 yr

[a]An inhalation route due to water use was not quantified.

[b]Although the assumed exposures to noncarcinogens are intermittent, the available toxicity values for systemic effects (RFDs) are most properly applied to chronic lifetime exposures (daily/70 yr). Therefore, since lifetime RfDs are used to calculate noncarcinogenic risks, resulting risks may be overestimated.

[c]Dermal intake is estimated assuming 100% and 25% body surface area exposed for future residential and worker exposures, respectively. Current residential exposures assume 100% and 25% body surface area exposed for consumptive and nonconsumptive use, respectively. A permeability constant equal to water (8x10-4 cm/hr) is assumed.

Table 8 (page 2 of 2)
CARCINOGENIC SLOPE FACTORS FOR THE VERONA WELL FIELD
CONTAMINANTS OF POTENTIAL CONCERN

	Oral Route				Inhalation Routes			
Chemical	Weight of Evidence[a]	Slope Factor[b] $(mg/kg\text{-}day)^{-1}$	Source[c]	Date	Weight of Evidence[a]	Slope Factor[b] $(mg/kg\text{-}day)^{-1}$	Source[c]	Date
Trichloroethene	B2	0.011	HEAST	7-1-89	B2	0.017	HEAST	7-1-89
Vinyl chloride	A	2.3	HEAST	7-1-89	A	0.295	HEAST	7-1-89

[a]U.S. EPA Carcinogen Assessment Group (CAG) Classification.
Group A: Human carcinogen--Sufficient evidence from epidemiological studies.
Group B1: Probable human carcinogen--At least limited evidence of carcinogenicity to humans.
Group B2: Probable human carcinogen--Combination of sufficient evidence in animals and inadequate data in humans.
Group C: Possible human carcinogen--Limited evidence of carcinogenicity in animals in the absence of human data.
Group D: Not classified--Inadequate animal evidence of carcinogenicity.
Group E: No evidence of carcinogenicity for humans--at least two adequate animal tests show no evidence of carcinogenicity.
[b]Sources of toxicity values:
IRIS--Integrated Risk Information System. U.S. EPA 1988 (accessed January 29, 1990).
HEAST--Health Effects Assessment Summary Tables--Quarterly Summary. U.S. EPA 1989
[c]Slope factor based on slope of dose response curve for carcinogens. Slope factor is expressed in risk per average daily contaminant intake, extrapolated to low dose levels from information at high dose levels. Estimate is at upper bound and not likely to be exceeded. True risk may be much lower, or zero.
[d]Based on Risk Assessment Forum unit risk of $5x10^{-5}$ (µg/l)-1.

Table 9 (page 2 of 4)
TOXICITY VALUES FOR NONCARCINOGENS AT VERONA WELL FIELD

Chemical	Reference Dose (RfD) mg/kg/day	Source[a]	Date	Critical Effect	UF[b]	MF[c]	Confidence in RfD[d]
ORAL ROUTE (continued)							
Chromium III	1.0	IRIS	8-1-89	No effects observed	100	10	Low
Chromium VI	0.005	IRIS	3-1-88	No effects reported	500	1	Low
Copper	0.037[f]	HEAST	7-1-89	Local GI irritation	--	--	--
Di-n-butylphthalate	0.1	IRIS	8-1-89	Increased mortality	1,000	1	Low
1,1-Dichloroethane	0.1	HEAST	7-1-89	None	1,000	--	--
1,1-Dichloroethene	0.009	IRIS	4-1-89	Hepatic lesions	1,000	1	Medium
trans-1,2-Dichloroethene	0.02	IRIS	1-1-89	Increased serum alkaline phosphatase in male mice	1,000	1	Low
Diethyl phthalate	0.8	IRIS	8-1-89	Decreased growth rate, food consumption and altered organ weights	1,000	1	Low
Ethylbenzene	0.1	IRIS	8-1-89	Liver and kidney toxicity	1,000	1	Low
Hexachloroethane	0.001	IRIS	3-1-88	Atrophy and degeneration of the renal tubules	1,000	1	Medium
Manganese	0.2	HEAST	7-1-89	CNS	100	--	--
Mercury	0.0003	HEAST	7-1-89	CNS	10	--	--
Methylene chloride	0.06	IRIS	10-1-89	Liver toxicity	100	1	Medium
4-Methyl-2-pentanone(MIBK)	0.05	IRIS	7-1-89	Increased liver and kidney weight and nephrotoxicity	1,000	1	Low

1

Table 9 (page 4 of 4)
TOXICITY VALUES FOR NONCARCINOGENS AT VERONA WELL FIELD

Chemical	Reference Dose (RfD) mg/kg/day	Source[a]	Date	Critical Effect	UF[b]	MF[c]	Confidence in RfD[d]
INHALATION ROUTE							
Bromomethane	0.008	HEAST	7-1-89	Paralysis and lung damage	1,000	--	--
2-Butanone	0.09	HEAST	7-1-89	CNS	1,000	--	--
Carbon disulfide	0.01 mg/m^3	EPA	9-20-89	Developmental effects	1,000	--	Medium
Chlorobenzene	0.005	HEAST	7-1-89	Liver and kidney effects	10,000	--	--
1,1-Dichloroethane	0.1	HEAST	7-1-89	Kidney damage	1,000	--	--
Methylene chloride	0.86	EPA	9-20-89	Kidney damage	1,00	--	Medium
Tetrahydrofuran	0.07 mg/m^3	EPA	9-20-89	Mucociliary depression, histological changes	3,000	--	Low
Toluene	2.0 mg/m^3	EPA	9-20-89	CNS effects, eye and nose irration	100	--	Medium
1,1,1-Trichloroethane	0.3	HEAST	7-1-89	Hepatotoxicity	1,000	--	--
Xylenes	0.3 mg/m^3	EPA	9-20-89	CNS effects, nose and throat irritation	100	--	Medium

[a] Sources of Toxicity Values:
IRIS - Integrated Risk Information System. U.S. EPA 1988 (accessed January 29, 1990).
HEAST - Health Effects Assessment Summary Tables - Quarterly Summary. U.S. EPA 1989.
EPA - Verified Inhalation Reference Doses, Memorandum from Daniel J. Guth, Ph.D Pollutant Assessment Branch, USEPA, September 20, 1989.
[b] UF-Uncertainty Factor.
[c] MF-Modifying Factor.
[d] Confidence rating from IRIS, either high, medium, or low.
[e] The oral RfD is being reconsidered by the RfD workgroup.
[f] Based on proposed drinking water standard of 1.3 mg/l.
[g] Nickel value based on nickel-soluble salts.

Table 10 Summary of Risk Estimates from Groundwater Downgradient of Source Areas					
Area	**Exposure Scenario**	**Noncarcinogenic Hazard Index**		**Excess Lifetime Cancer Risk**	
		Ingestion	**Dermal**	**Ingestion**	**Dermal**
Annex	Current Resident (nonconsumptive)	<0.01	<0.01	$1x10^{-6}$	$9x10^{-9}$
Annex	Current Resident (consumptive)	0.02	<0.01	$4x10^{-4}$	$1x10^{-6}$
Raymond Road	Current Resident	0.49	<0.01	$5x10^{-5}$	$5x10^{-7}$

Table 11 Summary of Risk Estimates from Groundwater Upgradient of Source Areas					
Area	**Exposure Scenario**	**Noncarcinogenic Hazard Index**		**Excess Lifetime Cancer Risk**	
		Ingestion	**Dermal**	**Ingestion**	**Dermal**
Paint Shop	Current Resident	<0.01	<0.01	$1x10^{-9}$	$2x10^{-11}$
Raymond Road	Current Resident	<0.01	<0.01	$4x10^{-7}$	$3x10^{-9}$

Table 14 Summary of Risk Estimates from Onsite Groundwater in the Paint Shop Area					
Site	Exposure Scenario	Noncarcinogenic Hazard Index		Excess Lifetime Cancer Risk	
		Ingestion	Dermal	Ingestion	Dermal
Paint Shop Onsite	Future Resident	18.7	0.03	$2x10^{-2}$	$3x10^{-5}$
Paint Shop Onsite	Future Worker	9.37	<0.01	$4x10^{-3}$	$3x10^{-6}$

Table 15 Summary of Risk Estimates from Onsite Groundwater in the Annex Area					
Site	Exposure Scenario	Noncarcinogenic Hazard Index		Excess Lifetime Cancer Risk	
		Ingestion	Dermal	Ingestion	Dermal
Annex Onsite	Future Resident	20.1	0.04	$7x10^{-2}$	$1x10^{-4}$
Annex Onsite	Future Worker	10.1	<0.01	$1x10^{-2}$	$1x10^{-5}$

TABLE 16

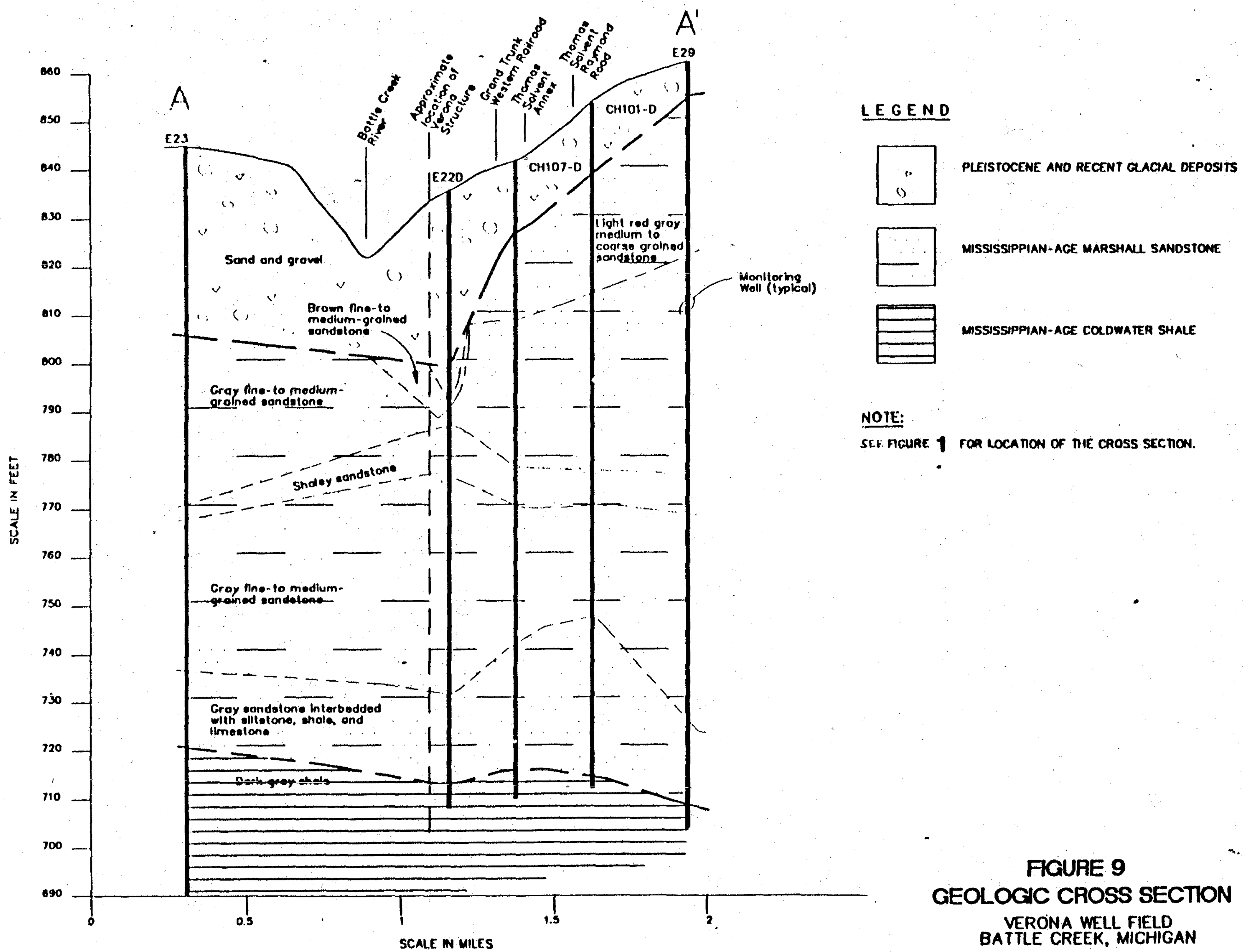
Verona Well Field, Battle Creek, Michigan
Revised Groundwater Cleanup Objectives (6/12/91)

Contaminant	MDL	Cancer Risk Goal[a]	Non-Carcinogen Risk-Ratio Goal[b]	MCL	MCLG	Michigan Act 307	Cleanup Objective
Acetone	5	--	3,500	--	--	700	700
Benzene	1	3	--	5	0	1	1
Chlorobenzene	1	--	700	100[c]	100[c]	100	100
Chloroform	1	14	350	100	--	6	6
1,1-Dichloroethane	1	1	3,500	--	--	700	1
1,2-Dichloroethane	1	1	--	5	0	0.4	1
1,1-Dichloroethene	1	0.2	315	7	7	7	1
1,2-Dichloroethene (cis)	1	--	--	70	70	1	1
1,2-Dichloroethene (trans)	1	--	700	100	100	100	100
Ethylbenzene	1	--	3,500	700	700	70	70
Methylene Chloride	1	11	2,100	--	--	5	5
Tetrachloroethene	1	2	--	5	0	0.7	1
Toluene	1	--	10,500	1,000	1,000	800	800
1,1,1-Trichloroethane	1	--	3,150	200	200	200	200
1,1,2-Trichloroethane	1	2	140	--	--	0.6	1
Trichloroethene	1	8	--	5	0	3	3
Vinyl Chloride	1	0.04	--	2	0	0.02	1
Xylene	1	--	70,000	10,000	10,000	300	300

[a]Presents concentrations associated with a $1x10^{-6}$ excess lifetime cancer risk based on ingestion of 2 liters per day of contaminated groundwater (70 kg adult, 350 d/yr, 30 yrs).
[b]Presents concentrations associated with reference dose for noncarcinogenic contaminants. Concentration divided by reference dose provides risk ratio.
[c]Proposed MCL or MCLG.

Notes:

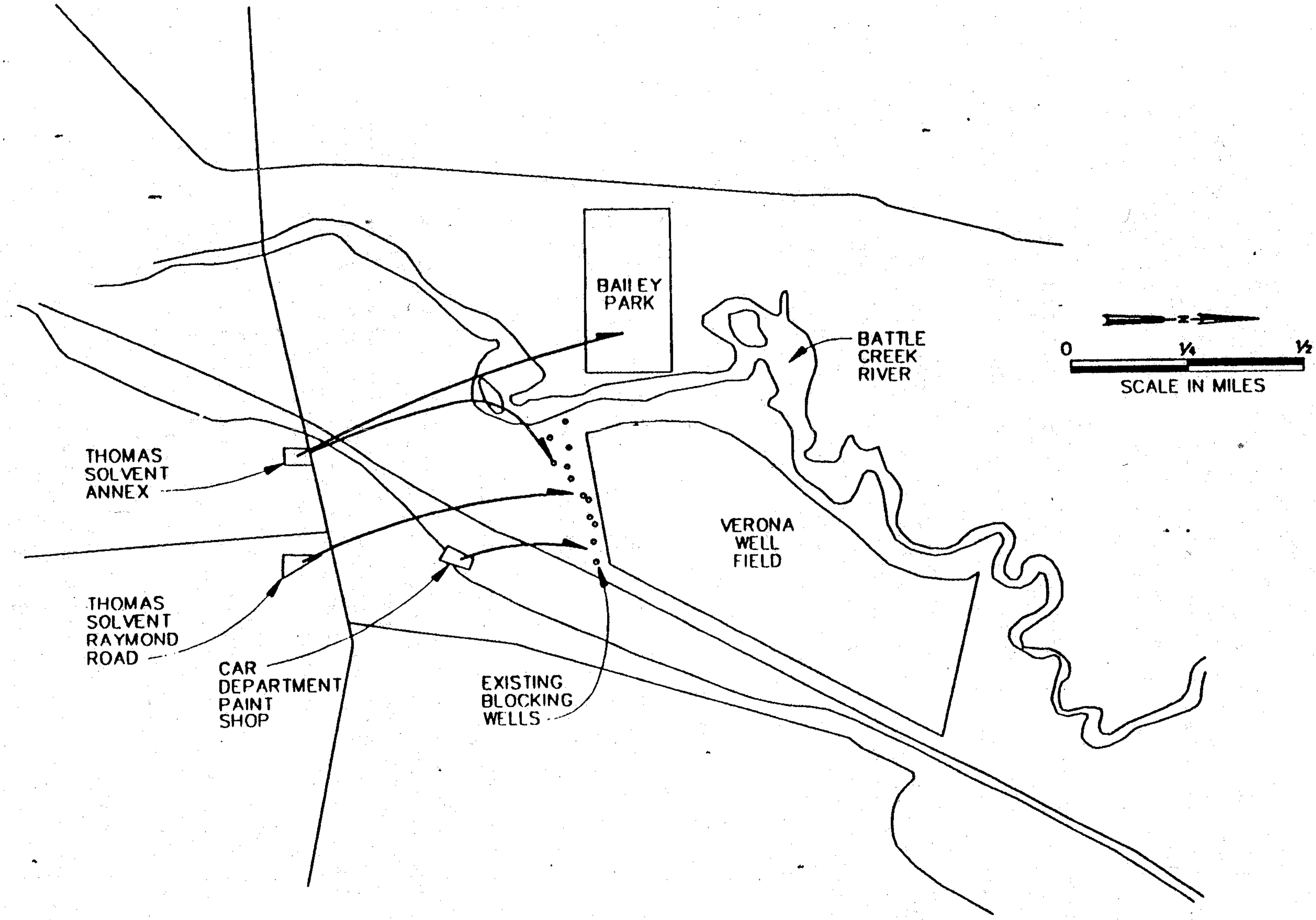
All units in $\mu g/l$
MDL = Acceptable Method Detection Limit
MCL = Maximum contaminant level
MCLG = Maximum contaminant level goal
-- = Indicates that no value is available



NOTE:

SEE FIGURE 1 FOR LOCATION OF THE CROSS SECTION.

FIGURE 9
GEOLOGIC CROSS SECTION
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN



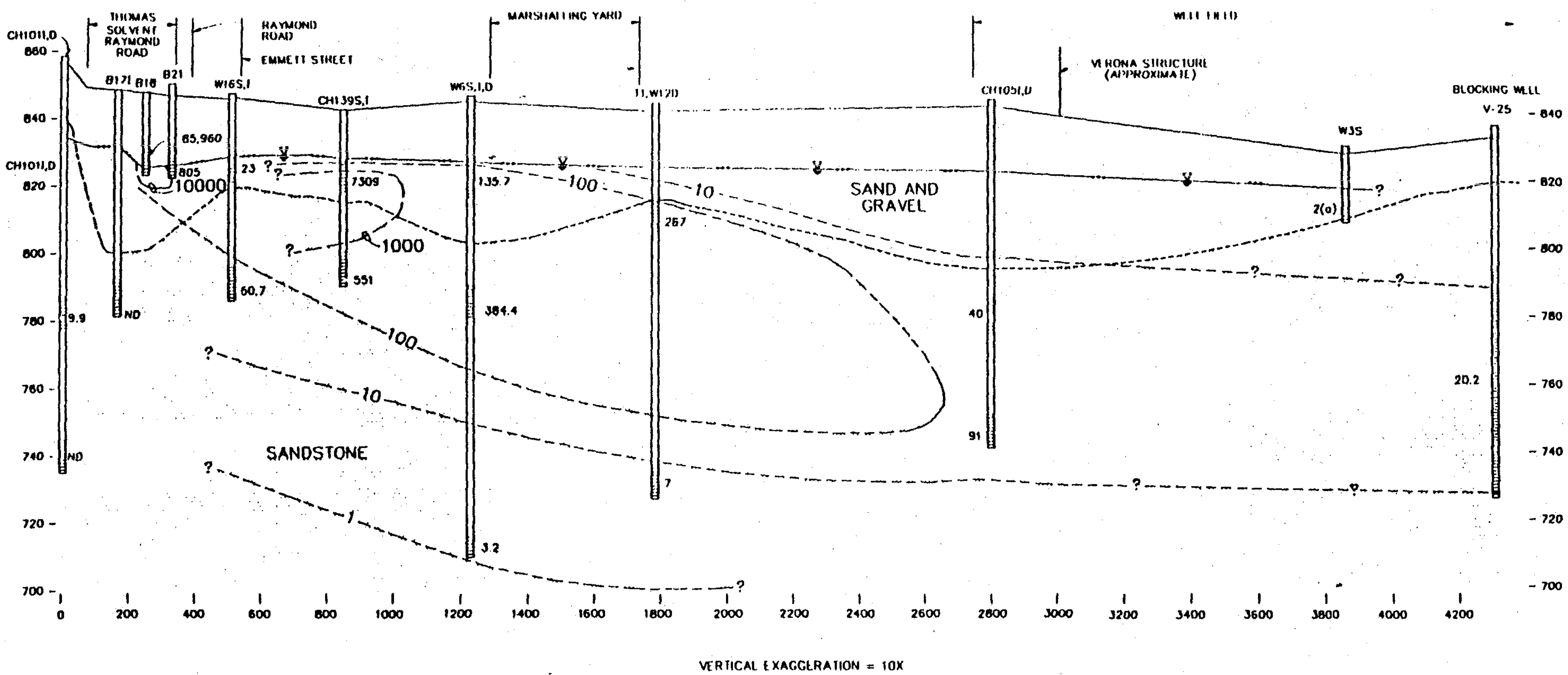
LEGEND

GROUNDWATER FLOW

EXISTING BLOCKING WELL

FIGURE 10
PROJECTED GROUNDWATER FLOW

VERONA WELL FIELD
BATTLE CREEK, MICHIGAN



LEGEND

a — CONCENTRATION WAS ACETONE, WHICH WAS ALSO A LAB CONTAMINANT. DATA POINT IS TO BE CONSIDERED PRELIMINARY.

- -10- - ISOCONCENTRATION CONTOUR. CONCENTRATION IS µg/l

∇ — GROUNDWATER LEVEL DETERMINED FROM WATER LEVEL MEASUREMENTS OBTAINED ON APRIL 2 AND 3, 1989.

ND — NOT DETECTED ABOVE METHOD DETECTION LIMIT

NS — NOT SAMPLED DURING APRIL 1989 SAMPLING EVENT

NOTES:

1. CROSS SECTIONS ARE GENERAL IN NATURE AND DO NOT PURPORT TO BE AN EXACT REPRESENTATION OF SUBSURFACE CONDITIONS BETWEEN MONITORING WELLS.
2. QUESTION MARKS ON ISOCONCENTRATION CONTOURS INDICATE INFERRED VALUES. QUESTION MARKS BETWEEN GEOLOGIC UNITS INDICATE CONTACT IS INFERRED.
3. WELL DEPTHS AND SCREENED INTERVALS ARE SHOWN FOR ILLUSTRATIVE PURPOSES.

FIGURE 11
CROSS SECTION — TOTAL VOCs
THOMAS SOLVENT RAYMOND ROAD
APRIL 1989
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

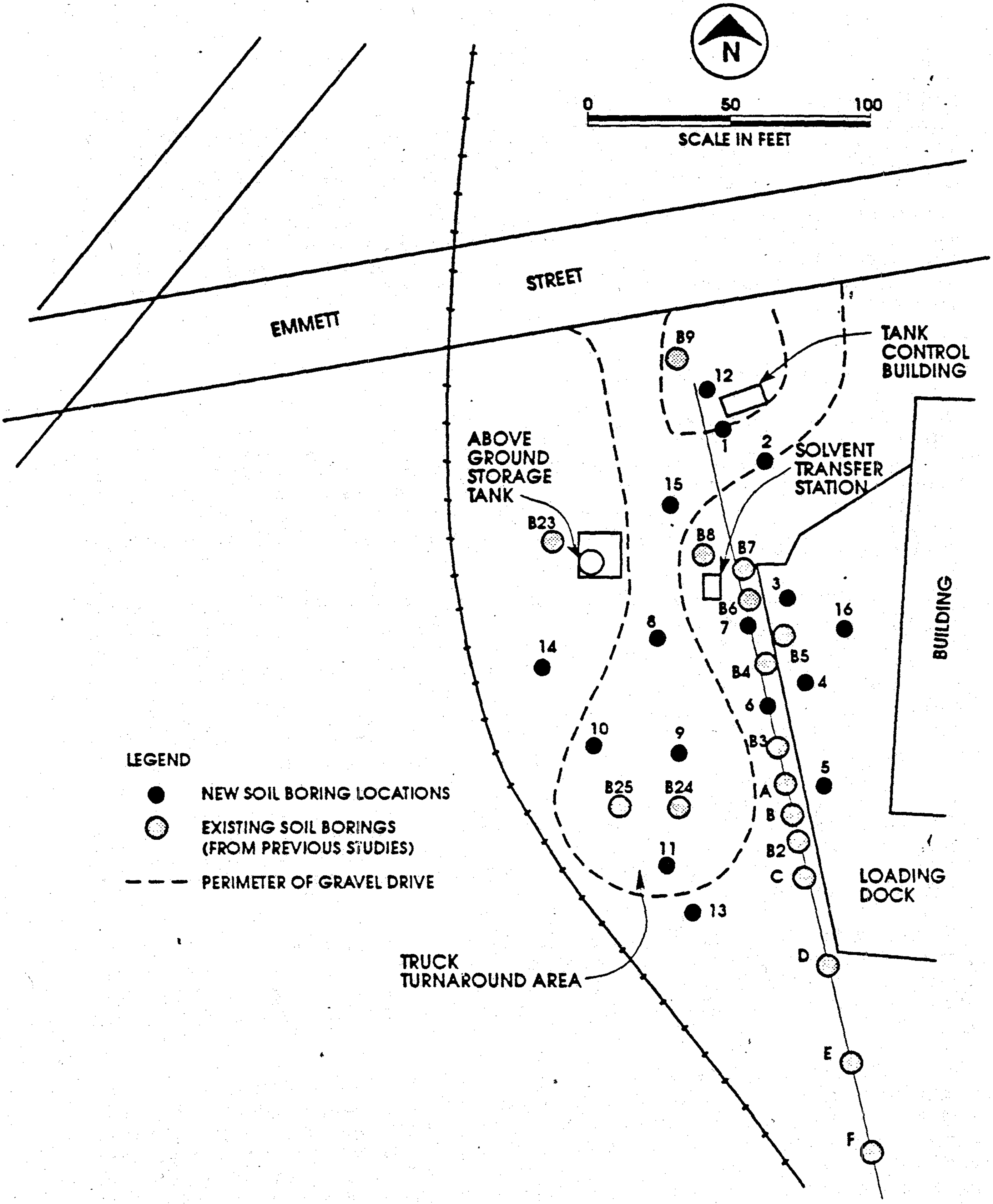


Figure 14
SOIL BORING LOCATIONS

VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

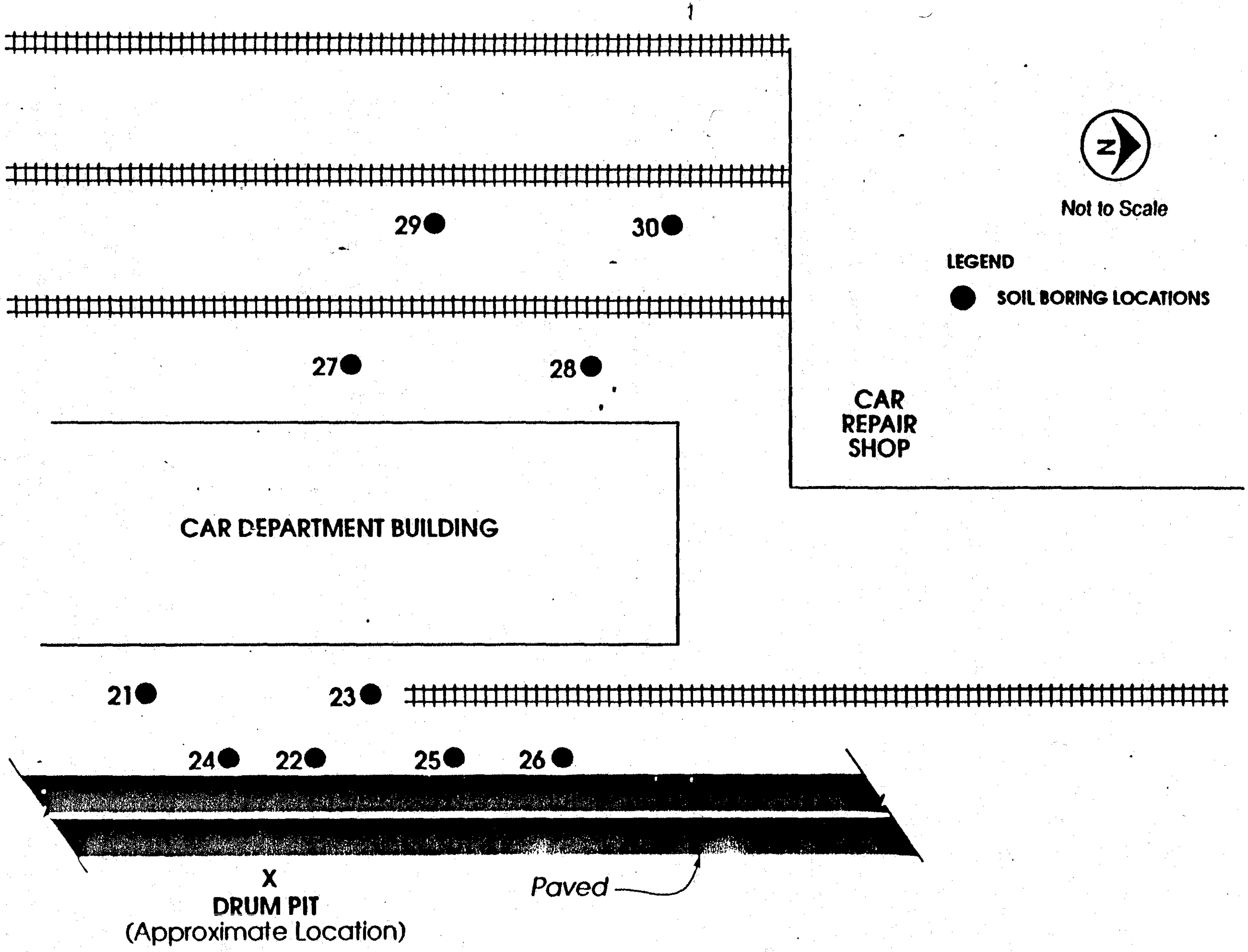


FIGURE 15
SOIL BORING LOCATIONS
GRAND TRUNK WESTERN RAILROAD PAINT SHOP
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

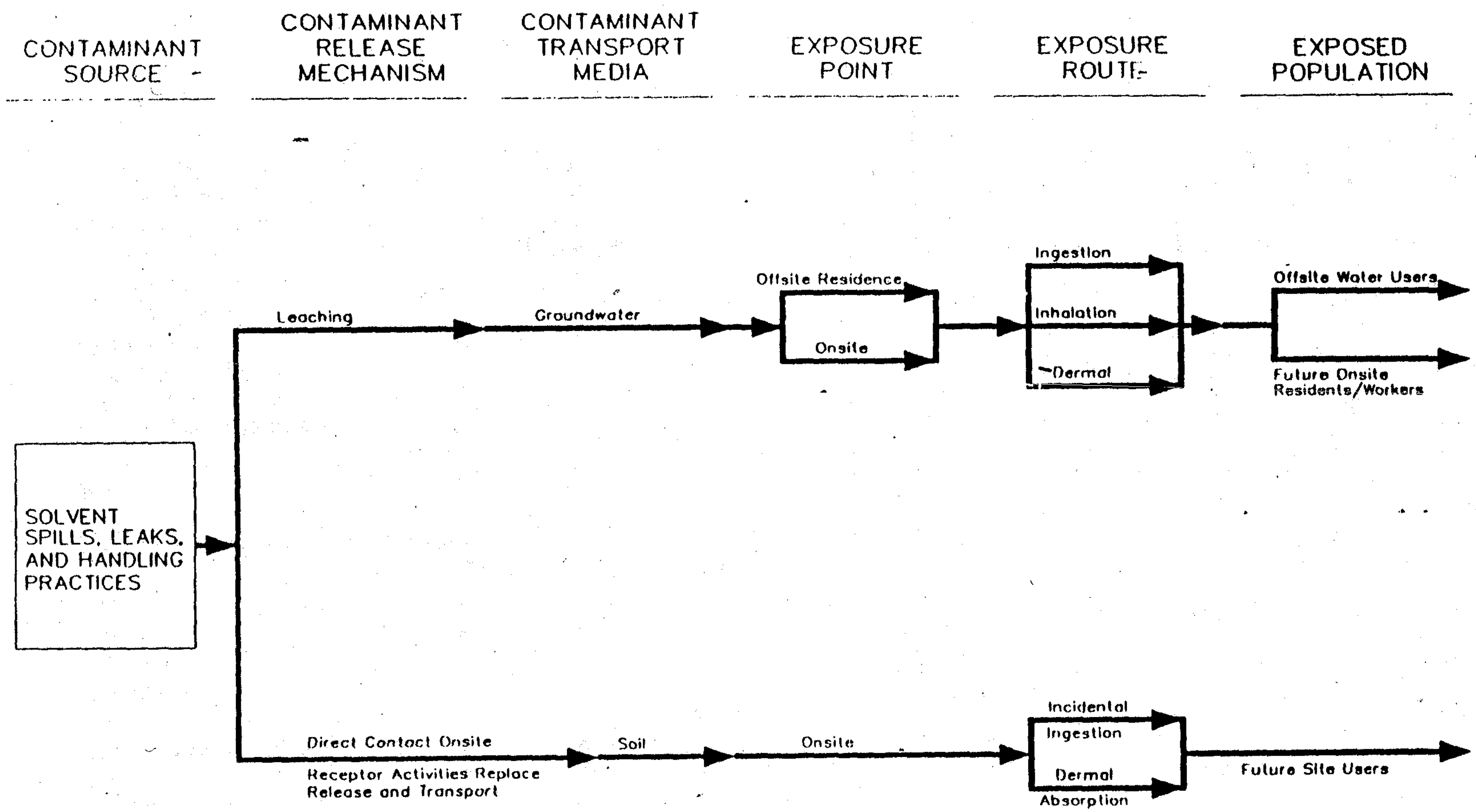
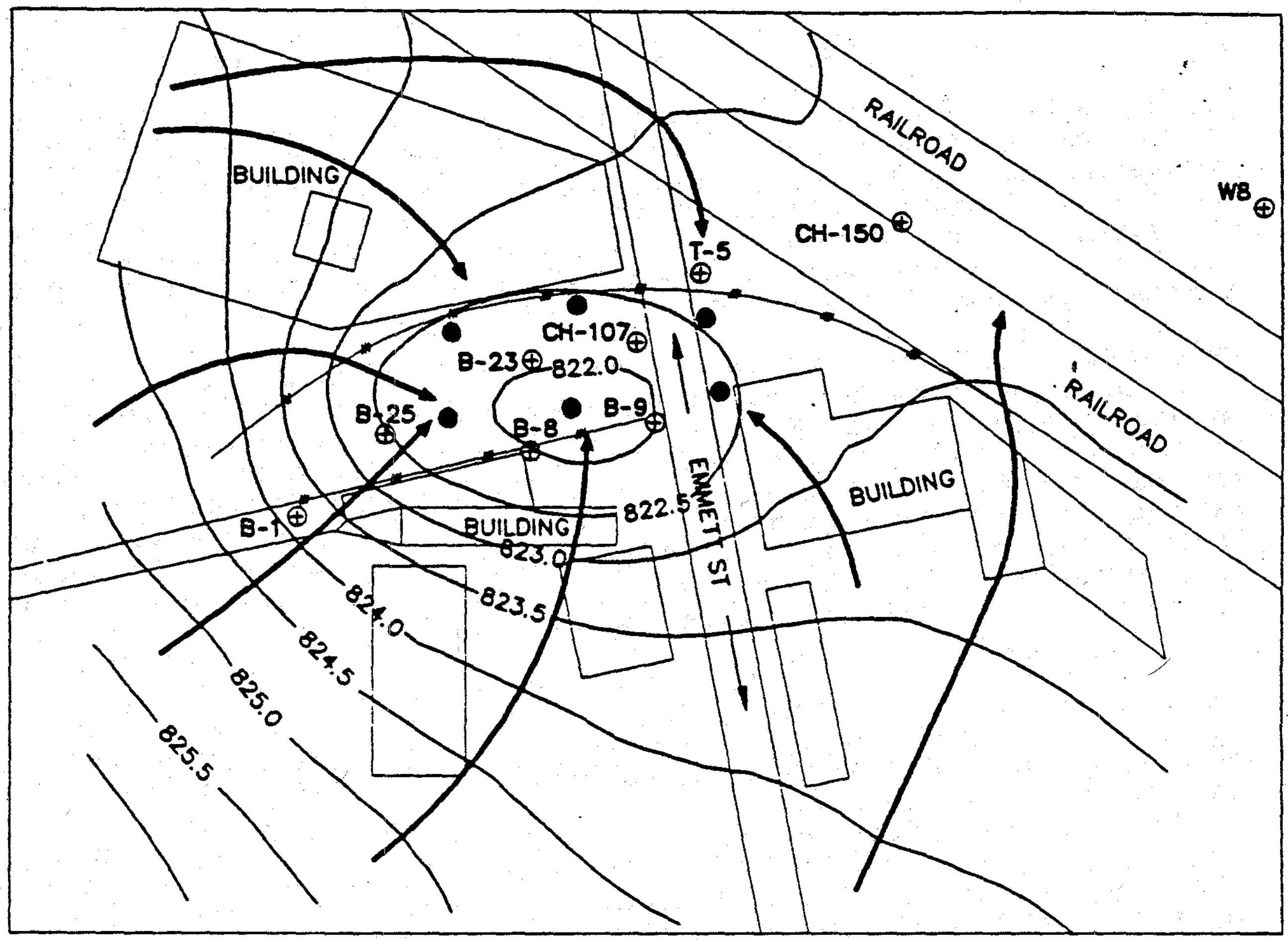


FIGURE 16

PLAUSIBLE EXPOSURE PATHWAYS

VERONA WELL FIELD
BATTLE CREEK, MICHIGAN



LEGEND

⊕ B-23	MONITORING WELL
822.0	GOUNDWATER ELEVATION CONTOUR, UNCONSOLIDATED UNIT
(arrow)	GROUNDWATER FLOW DIRECTION
●	EXTRACTION WELL

FIGURE 17
GROUNDWATER SURFACE AND FLOW DIRECTIONS AT THOMAS SOLVENT ANNEX FOR ALTERNATIVE 3

VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

Table 18
Combinations of Media-Specific Alternatives to Form Sitewide Alternatives

	Media-Specific Alternative						
	Soil			Groundwater			
Sitewide Alternative	No Action	SVE at Both Source Areas	Excavation/ Incineration at Both Sources	No Action	Down Gradient Purge Wells	Collection/ Treatment of Source Areas	In Situ Biological at Annex
Alternative 1	X			X			
Alternative 2	X				X		
Alternative 3	X				X	X	
Alternative 4		X			X		
Alternative 5			X		X		
Alternative 6		X			X	X	
Alternative 7			X		X	X	
Alternative 8		X			X	X	X

X = Component of the Sitewide Alternative

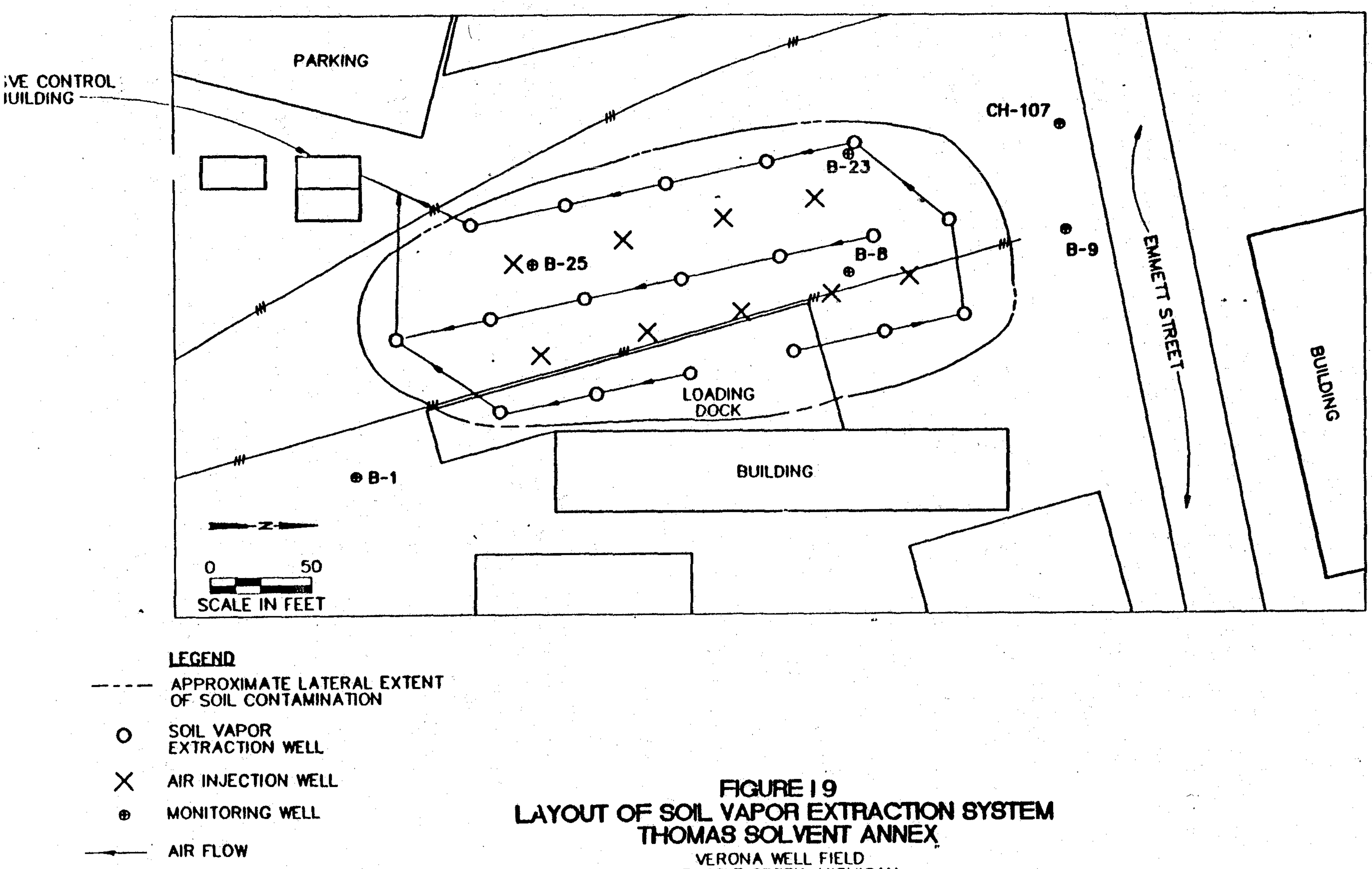
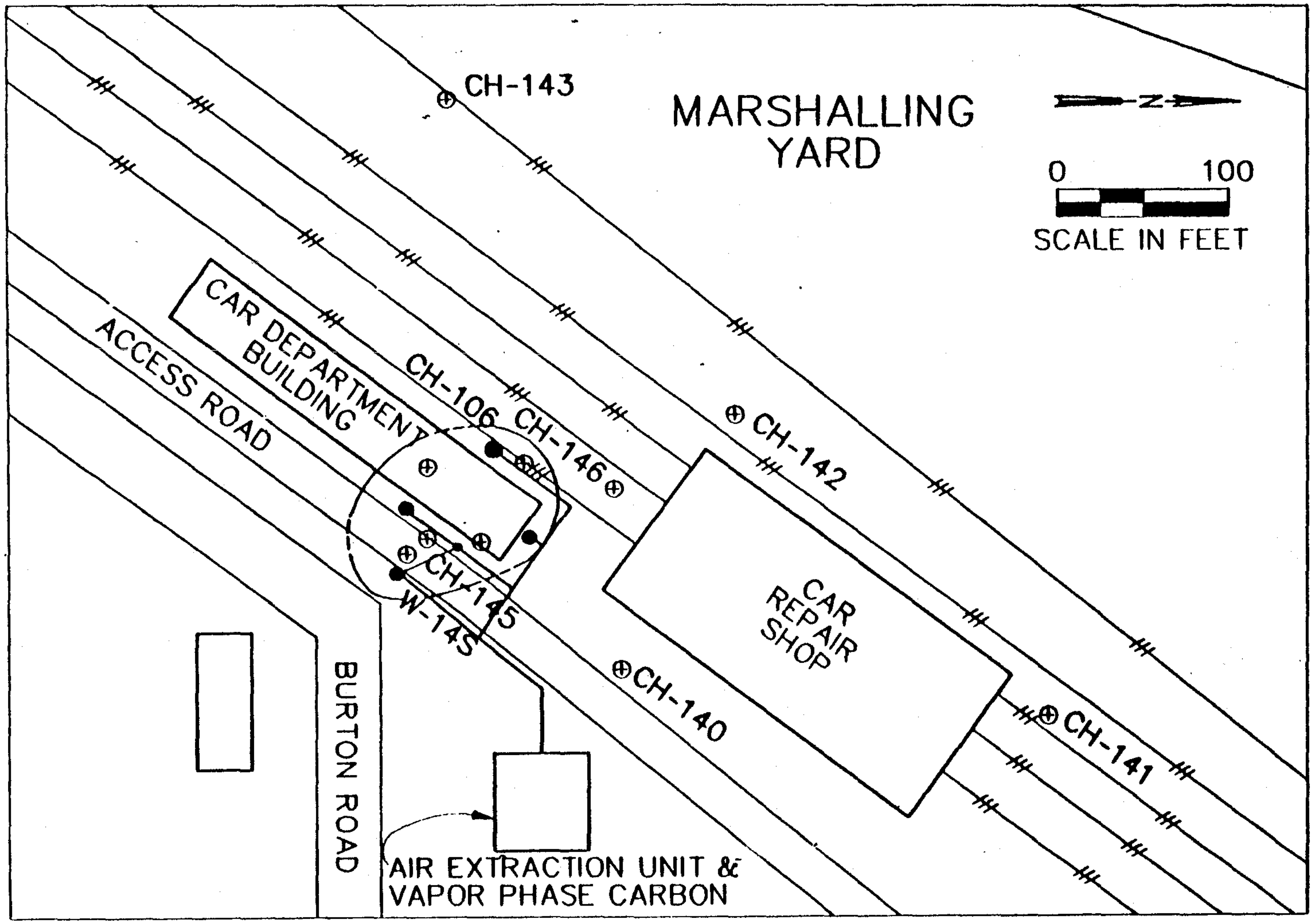


FIGURE 19
LAYOUT OF SOIL VAPOR EXTRACTION SYSTEM
THOMAS SOLVENT ANNEX
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

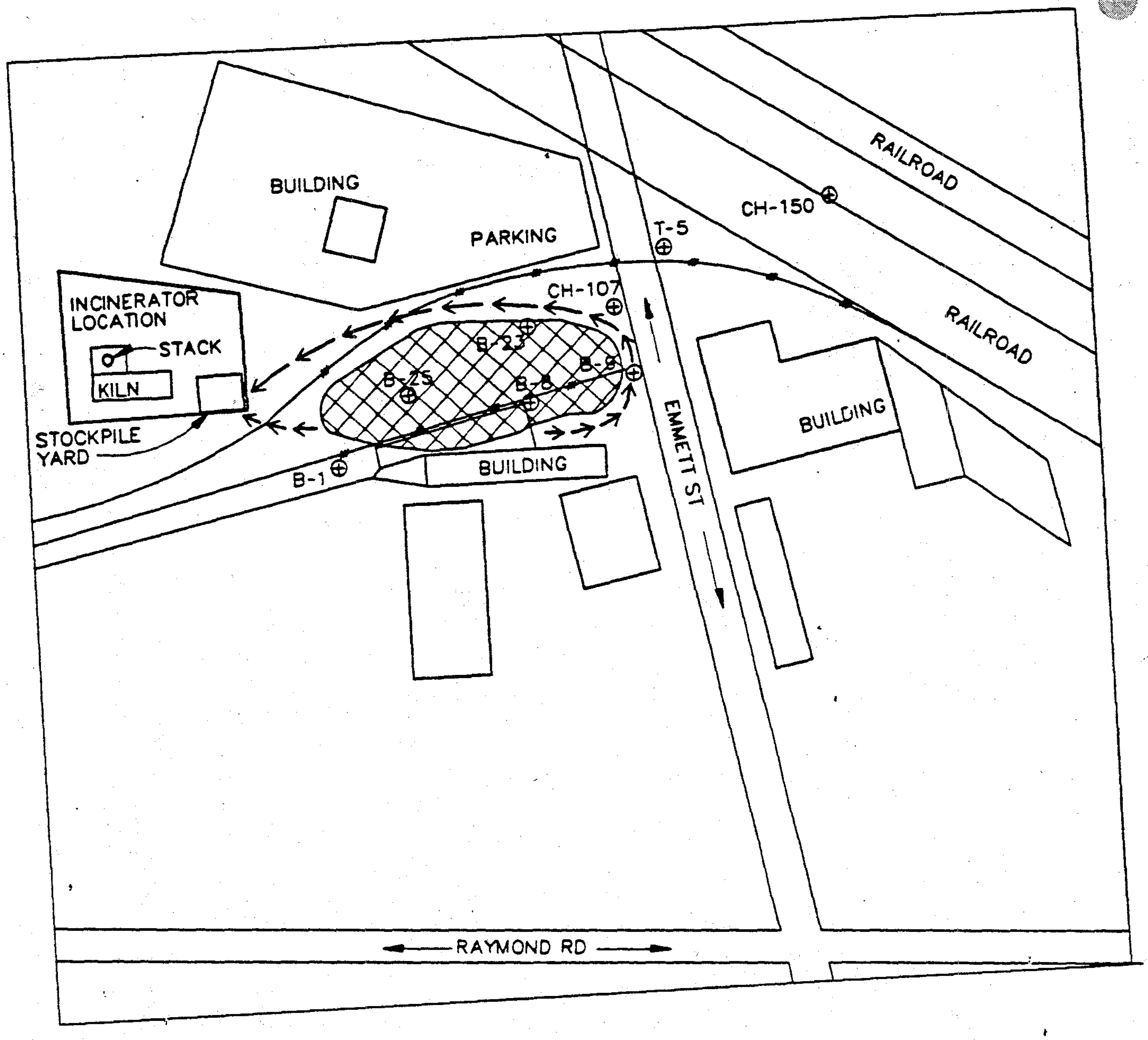


LEGEND

---- APPROXIMATE EXTENT OF SOIL CONTAMINATION

● EXTRACTION WELL

FIGURE 20
LAYOUT OF SOIL VAPOR EXTRACTION SYSTEM
CAR DEPARTMENT AREA
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN



LEGEND

EXAMPLE HAUL ROUTE

SOURCE AREA TO BE EVACUATED

N

0 200

SCALE IN FEET

FIGURE 21
INCINERATOR LOCATION AND LAYOUT
THOMAS SOLVENT ANNEX
ALTERNATIVES 5 AND 7
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

Prior to excavation, some or all of the building would have to be demolished. Excavation of soils will likely result in fugitive VOC releases that exceed State air quality standards and would require vapor suppressants and soil covers.

Incinerators have demonstrated a high percentage of destruction for VOCs. Once treated, it is assumed that soils would meet the cleanup objectives and would be delisted and replaced on the site. The FS estimated that excavation and incineration of the contaminated soils at the Annex and Paint Shop would be completed in approximately 7 months. No groundwater treatment at the source areas is included with this alternative, but Alternative 2, the additional purge wells, would be included. Because groundwater at the source areas would not be extracted and treated, cleanup times for the aquifer between the source areas and the downgradient purge wells is expected to be greater than 50 years.

Excavation and incineration of soils would meet the requirements of Michigan's Act 307 Rules for soil remediation. Air pollution control devices may need to be implemented to comply with Federal and State requirements for air emissions, and the system could be designed and managed to meet all action and location specific ARARs. Since this alternative does not include groundwater extraction at the source areas, it is unlikely that Federal MCLs or groundwater requirements of Michigan Act 307 would be met for some time.

Costs for this alternative would result from the operation and maintenance of the existing blocking wells, the additional downgradient purge wells and excavation and incineration of approximately 30,000 cubic yards of soil. It is estimated that Alternative 5 would have a capital cost of $20,000,000. Operation and maintenance costs per year would be approximately $500,000, with a present worth of $26,000,000.

Alternative 6 - Groundwater Treatment and In Situ Soil Treatment

Alternative 6 combines Alternatives 2, 3, and 4 to include continued operation of the existing blocking wells, installation of additional purge wells downgradient of the source areas, groundwater collection and treatment at the source areas, and in situ vapor extraction of source area soils.

Removing vadose zone contamination would limit contaminant migration from soils to groundwater, and active groundwater collection at the sources would greatly reduce contaminant plume concentrations migrating from the sources. The FS estimated that soil clean up goals could be achieved in 2 to 5 years. Downgradient contamination would migrate to the new purge wells and would result in clean up of the downgradient portion of the aquifer. The existing blocking wells would also be operational and would result in removal of contamination between the blocking wells saturated soils at the Annex.

The addition of bioremediation at the Annex with groundwater extraction would enhance the removal of contaminants adsorbed to the soils in the saturated zone. The groundwater collection and treatment system would extract groundwater, remove contaminants through air stripping, add oxygen and other nutrients to enhance bioremediation, and then replace the water back into the aquifer. Figure 22 presents a conceptual layout of the hydraulic control required for the system. Figure 23 shows the nutrient supply systems and the system's conceptual mass balance. The FS estimated the need for ten extraction wells with a total pumping rate of 110 gpm. Excess treated water would be discharged to the Battle Creek River.

Implementing bioremediation at the Annex would increase the removal of contaminants in the saturated zone and decrease the time required to achieve cleanup goals. The FS estimates ten years to attain cleanup numbers at the Annex. However, as with Alternatives 6 and 7, groundwater cleanup goals would not be met at the Paint Shop for at least 20 years. All other estimated times for attainment of cleanup goals are the same as Alternatives 6 and 7.

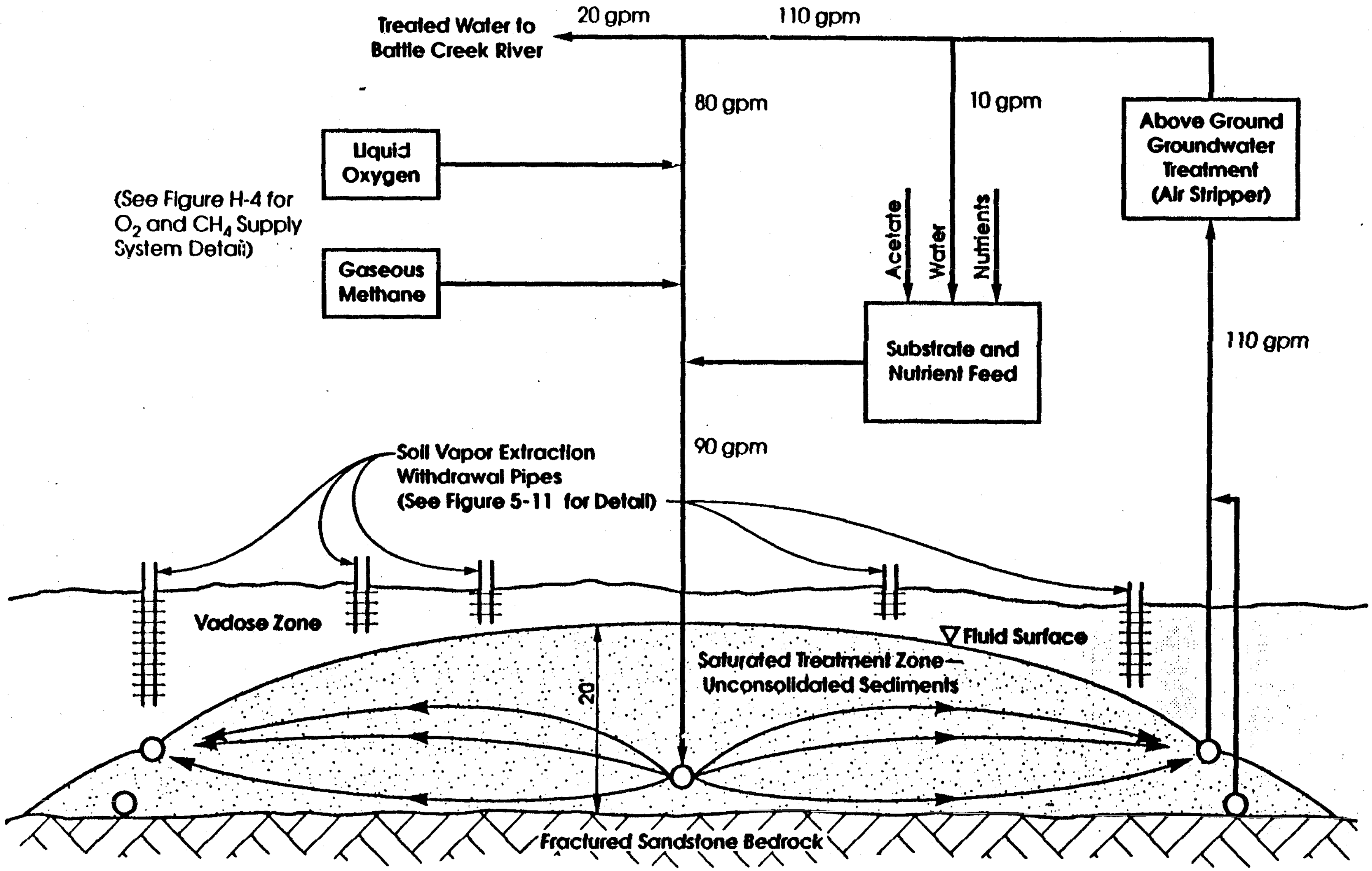
Alternative 8 is expected to comply with all Federal and State chemical-specific ARARs for soils and groundwater. The treatment systems could be designed to meet all location- and action-specific ARARs as well. However, the necessary injection of nutrients into the aquifer would need to be evaluated before a determination is made with regard to ARARs.

Costs for this alternative would result from the implementation, operation and maintenance of the existing blocking wells, the additional purge wells, source area groundwater collection and treatment, source area soil vapor extraction, and bioremediation. It is estimated that Alternative 6 would have a capital cost of $7,400,000. Operation and maintenance costs per year would be approximately $960,000, with a present worth of $16,000,000.

VIII. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

In order to determine the most appropriate alternative that is protective of human health and the environment, attains ARARs, is cost-effective, and utilizes permanent solutions and treatment technologies to the maximum extent practicable, the remedial alternatives developed in the FS have been evaluated and compared using the nine criteria set forth in the NCP. The nine criteria and a brief description of each is listed below.

* <u>Overall Protection of Human Health and the Environment</u> addresses whether or not a remedy provides adequate protection and describes how risks are posed through each pathway are eliminated, reduced or controlled through treatment,



Note: Not to Scale

Figure 23
ALTERNATIVE 8: CONCEPTUAL CROSS-SECTIONAL LAYOUT
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

	Alternative 1 No Action (Existing Blocking Wells)	Alternative 2 Downgradient Purge Wells	Alternative 3 Groundwater Collection at Sources & Treatment via Air Stripper	Alternative 4 In Situ Soil Vapor Extraction at Sources	Alternative 5 Excavation and Incineration at Sources	Alternative 6 Groundwater Collection and Treatment via Air Stripper; In Situ SVE	Alternative 7 Groundwater Collection and Treatment; Excavation and Incineration at Source Areas	Alternative 8 Groundwater Collection and Treatment; In Situ SVE at Annex and Paint Shop, In Situ Biological Treatment
Overall Protection of Human Health and Environment	*Residual risk due to direct contact with contaminated soil is 7×10^{-4}.* Potential exists for contaminants to migrate through or around blocking well system and into well field.	*Residual risks in the soil and groundwater would be same as Alt. 1.* New blocking well system would significantly reduce likelihood of contaminants bypassing *blocking well system.* Risks for groundwater ingestion from area between the two lines of blocking wells expected to be $<1\times10^{-6}$ after 12 years. Residual risk from ingestion of groundwater from private wells is 1×10^{-2}.	*Residual risk in soil same as Alt. 1.* Residual risk in 90% of the aquifer may be $<1\times10^{-6}$ after 30 years. Residual risk in groundwater at source areas will likely exceed *1×10^{-6} for more than 50 years. Well field protection same as Alt. 2.*	Residual risks in soil expected to be $<1\times10^{-6}$ after 5 years. *Groundwater risks and effectiveness of the blocking well system is the same as Alt. 2.*	Residual risks in soil expected to be $<1\times10^{-6}$ after 1 year. *Groundwater risks and effectiveness of the blocking well system is the same as Alt. 2.*	Residual soil risks could be $<1\times10^{-6}$ after 5 years, and residual groundwater risks probably would be $<1\times10^{-6}$ in 20 to 30 years throughout the entire aquifer.	*Same as Alt. 6 except* soil risks could be $<1\times10^{-6}$ after 1 year.	*Same as Alt. 6 for soil.* There is more likelihood that groundwater risks could be reduced to $<1\times10^{-6}$ and that it could be done in a shorter period of time than with *Alts. 6 and 7.*
Compliance with ARARs	No action alternative would not *meet chemical-specific ARARs.*	Groundwater treatment would be able to *meet chemical specific* ARARs for effluent discharge, and action specific ARARs for air stripping technology. Chemical-specific ARARs and requirements of Michigan Act 307 violated at source areas.	Majority of ARARs relating to groundwater and groundwater treatment would be met. Requirements of Michigan Act 307 rules would be violated at source areas.	SVE would be able to meet technology-based limits for vapor emission. Thermal regeneration of spent carbon may be required to meet land disposal restrictions (LDRs) on solvent wastes. *Other components same as for Alt. 2.*	Excavation and incineration would comply with all action specific ARARs relating to these technologies. Attainment of fugitive emission regulations during excavation would require frequent monitoring and control. LDRs would apply to excavation soils, but requirements would be met through incineration. *All other components same as for Alt. 2.*	All ARARs are expected to be met *for contaminant levels, treatment,* and discharge/disposal.	*Same as Alt. 6.*	In situ bioremediation expected to comply with all ARARs. Michigan WRCA regulates discharge to aquifers and a waiver would be required prior to the implementation of this alternative. *All other components same as for Alt. 6.*
Long-Term Effectiveness								
• Magnitude of residual risk	Contaminated groundwater may travel to Bailey Park wells. Lack of protection against future installation of private wells south of the blocking wells may result in total risk from groundwater ingestion of 1×10^{-2}. Lack of protection against excavation into contaminated subsurface soils may result in total risk from soil ingestion of 7×10^{-4}.	*Magnitude of residual groundwater risk same as for Alt. 1,* but potential area for exposure reduced by 25% after 12 years, when a portion of the aquifer may be remediated. *Soil risks same as for Alt. 1.* New blocking wells would increase the long term reliability of the blocking well system.	*Soil risks same as Alt. 1.* Groundwater risks reduced to $<1\times10^{-6}$ in 90% of aquifer.	Subsurface soil contaminants in vadose zone would remain, but residuals would be $<1\times10^{-6}$ for direct contact exposure. *Groundwater risks same as Alt. 2.* Soil contaminants in saturated zone would remain.	*Same as Alt. 4.*	Soil risk $<1\times10^{-6}$ after 5 years, and groundwater risk $<1\times10^{-6}$ after 20 to 30 years.	*Same as Alt. 6.*	Potential for more complete remediation, especially in the saturated zone. All objectives met at the Annex within 10 years. Remediation of groundwater at the paint shop may require 20 to 30 years.
• Adequacy and reliability of controls	Not adequate because contaminants could migrate to Bailey Park and toward the river; also does not address soil contaminant *sources.*	Institutional controls with uncertain reliability needed to prevent exposure to soil and contaminated groundwater.	*Same as Alt. 2.*	Not adequate to control continued groundwater contamination. Health advisories would be relied on to prevent groundwater exposure. *No control over soil contact* required.	*Same as Alt. 4.*	Soil and groundwater treatment should provide long term adequate control of contaminants.	*Same as Alt. 6.*	In situ biological treatment still unproven for chlorinated VOCs.
Reduction of Toxicity, Mobility, and Volume								
• Treatment processes used and materials treated	Air stripper and vapor phase carbon *continue to treat groundwater* contaminants. Contaminants thermally destroyed during carbon regeneration.	*Same as Alt. 1, though* more *groundwater would be treated with* air stripping.	Air stripping and carbon used to *treat 3,700 gpm of groundwater.*	Soil vapor extraction for VOCs in vadose zone soils. Air stripping for groundwater contaminants removed by blocking wells. Contaminants removed with SVE would be thermally destroyed.	Incineration and SVE of all organic contaminants in vadose zone soils. Air stripping for groundwater contaminants removed by blocking wells.	*Same as Alts. 3 and 4.*	*Same as Alts. 3 and 5.*	Bioremediation of groundwater and saturated soils. SVE for vadose zone contaminants. Air stripping of VOC groundwater contaminants.

NOTE: Italics mean information is the same as or similar to information for other alternatives.

Table 19
DETAILED EVALUATION OF ALTERNATIVES
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

	Alternative 1 No Action (Existing Blocking Wells)	Alternative 2	Alternative 3 Groundwater Collection at Sources & Treatment via Air Stripper	Alternative 4 In Situ Soil Vapor Extraction at Sources	Alternative 5 Excavation and Incineration at Sources	Alternative 6 Groundwater Collection and Treatment via Air Stripper; In Situ SVE	Alternative 7 Groundwater Collection and Treatment; Excavation and Incineration at Source Areas	Alternative 8 Groundwater Collection and Treatment; In Situ SVE at Annex and Paint Shop, In Situ Biological Treatment
Implementability								
• Technical feasibility	Alternative already in place.	Well installation and groundwater capture poses no difficult technical problems. Additional monitoring wells would provide added protection of the well fields.	*Same as Alt. 2*	SVE technology already demonstrated at neighboring source would be similar to subsurface environment and contaminant types	Considerably complex to mobilize and operate incinerator, but technology is considered reliable and effective.	*Same as Alts. 2 and 4*	*Same as Alts. 2, 3, and 5.*	In situ biodegradation is an innovative technology, previously undemonstrated in full scale. Extensive pilot and bench scale testing required. Technical problems may arise that could cause significant delays
• Availability of services and materials		Equipment and drillers readily available.	*Same as Alt. 2*	*Same as Alt. 2.* Operators and vendors of SVE system may be limited, but are generally available.	Limited number of mobile incinerator units available nationwide, but are generally available.	*Same as Alts. 2 and 4.*	*Same as Alts. 2, 3, and 5.*	Limited number of consultants or vendors with experience for in situ chlorinated VOC bioremediation.
• Administrative feasibility		Easements maybe required for well installation. Substantive requirements of air and water permits must be met.	*Same as Alt. 2.*	*Same as Alt. 2.*	Negative public perception may be difficult to overcome. *Other alternative components are similar to Alt. 2.* Treated soil may have to be delisted before it can be placed onsite	*Same as Alt. 2.*	*Same as Alts. 2, 3, and 5.*	Permission probably necessary before acetate, nutrients, O_2 and CH_4 could be injected into the groundwater. Complete capture of these materials would need to be demonstrated before waiver could be obtained. *Other alternative components same as Alt. 2.*
Cost								
• Capital Cost	—	$1.4 million	$3.9 million	$3.5 million	$20 million	$6.2 million	$22 million	$7.4 million
• Annual O&M[a]	$160,000	410,000	590,000	620,000	500,000	840,000	720,000	960,000
• Present Worth (5%, 30 years)	2.50 million	6.6 million	11.7 million	9.3 million	26 million	15.3 million	31.1 million	15.8 million

[a] The annual O&M costs presented here do not include the costs associated with the groundwater and soil vapor extraction systems at the Thomas Solvent Raymond Road source area

NOTE: Italics mean information is the same as or similar to information for other alternatives.

Table 19 (continued)
DETAILED EVALUATION OF ALTERNATIVES
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

engineering controls, or institutional controls.

* Compliance With ARARs addresses whether or not a remedy will meet all of the applicable or relevant and appropriate requirements of other Federal and State environmental statutes and/or provide grounds for invoking a waiver.

* Long-Term Effectiveness and Permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time once cleanup goals are achieved.

* Reduction of Toxicity, Mobility, or Volume refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the site.

* Short-Term Effectiveness addresses the period of time needed to achieve protection, and any adverse impacts on human health and the environment that may be posed during construction and implementation period until cleanup goals are achieved.

* Implementability is the technical and administrative feasibility of a remedy, including the availability of materials and services needed to implement a particular option.

* Cost includes estimated capital and operation and maintenance costs and net present worth costs.

* State Acceptance indicates whether, based on its review of the RI/FS and proposed plan, the State concurs, opposes, or has no comment on the preferred alternative.

* Community Acceptance is based on comments received from the public during the public comment period. These comments are assessed in the responsiveness summary attached to the ROD following review of the public comments received on the RI/FS and the proposed plan.

A summary of the evaluation for each alternative is summarized in Table 19. Following the individual evaluations, alternatives were compared in order to identify the alternative providing the best balance among the nine criteria. The results of the comparison are discussed below.

A. Threshold Criteria

The two most important criteria are statutory requirements that must be satisfied by any alternative in order for it to be eligible for selection. These two criteria are discussed below.

	Alternative 1 No Action (Existing Blocking Wells)	Alternative 2	Alternative 3 Groundwater Collection at Sources & Treatment via Air Stripper	Alternative 4 In Situ Soil Vapor Extraction at Sources	Alternative 5 Excavation and Incineration at Sources	Alternative 6 Groundwater Collection and Treatment via Air Stripper; In Situ SVE	Alternative 7 Groundwater Collection and Treatment; Excavation and Incineration at Source Areas	Alternative 8 Groundwater Collection and Treatment; In Situ SVE at Annex and Paint Shop, In Situ Biological Treatment
Reduction of Toxicity, Mobility, and Volume (continued)								
• Expected reductions in toxicity, mobility, volume	Existing blocking wells remove about 500 lb of contaminants per year. No portion of the aquifer would be actively restored.	25% of aquifer remediated through pumping and air stripping. More than 1,000 lb of VOCs removed per year.	*90% of aquifer remediated through* pumping and air stripping	30,000 cy of contaminated soil and 37,400 lb of VOC mass, 25% of aquifer remediated	30,000 cy of contaminated soil and 37,400 lb of VOC mass, 25% of aquifer remediated	30,000 cy of contaminated soil *and 37,400 lb of VOC mass*, complete remediation of aquifer.	*Same as Alt 6.*	*Same as Alt 6, plus additional* 100 lb of contaminant mass removed from saturated zone soil.
• Irreversibility of treatment	Irreversible, unless pumping conditions are altered.	*Irreversible*, unless pumping conditions are altered	*Same as Alts 1 and 2*	Irreversible.	Irreversible	Irreversible.	*Irreversible.*	Irreversible.
• Type and quantity of treatment residual	1,850 gpm treated discharge to Battle Creek River.	3,000 gpm treated discharge to Battle Creek *River*.	3,700 gpm discharged to Battle Creek River.	*Same as Alt 2 for groundwater* 30,000 cy of treated soil	*Same as Alt. 4*	*Same as Alt 3 for groundwater and Alt 4 for soil.*	*Same as Alts. 3 and 5*	*Same as Alt 6.*
Short-Term Effectiveness • Protection of community during remedial action	Existing blocking wells may not be effective *in protecting the well* field. Contaminants could migrate around blocking wells to the Baily Park wells or through blocking wells if the system is turned off for maintenance.	New purge wells would prevent migration of contaminated groundwater to the Bailey Park production wells. *Community protection at source areas same as Alt 1. Some disruption to local* traffic may occur as additional wells/piping are installed	Risks from air stripper emissions would be mitigated by treatment (adsorption and incineration). No effects on surrounding residents expected. Some disruption to local traffic may occur as additional wells/piping are installed	Risks posed by SVE air emissions would be mitigated by emission *treatment to meet ambient air* quality standards. *Effectiveness of blocking well system is same as Alt 2*	Risks posed by excavation mitigated through the use of engineered controls. Fugitive air monitoring required to monitor *compliance*. Pollution control equipment would be needed on *incinerator to mitigate emissions*. May be public concern with onsite incineration.	*Same as Alts 3 and 4.*	*Same as Alts. 3, 4, and 5.*	*Same as Alts. 3 and 4.* If nutrients added to the aquifer escape from the groundwater extraction system, some risk to downgradient groundwater users could occur.
• Protection of workers during remedial action	*Ongoing maintenance* of extraction system, blocking wells, and air stripper *poses potential VOC*-inhalation exposure risk for workers.	*Same as Alt 1*: also, potential exposure to contaminants during drilling. Personal protective gear (Level C-D) needed to protect workers.	Because drilling would occur in source areas, personal protective gear (Level B-C) would be necessary. *Operation of extraction system, blocking wells, and air stripper poses same VOC inhalation exposure risk for workers as Alt. 1.*	Some risk implicit with operation of catalytic oxidation because of high temperatures and potential *for contaminant exposure. Risks regarding SVE installation similar to Alt 3, although frequency of well* installation exposures may increase.	Alt. 5 has significantly higher risks to workers because of excavation of contaminated soil. Consistent enforcement of health and safety protective Levels B and C may be *required during excavation in high* hazard environment. *Same as Alt 2 for groundwater risks for blocking wells.* Incinerator operation also poses risks for workers	*Same as Alts. 3 and 4.*	*Same as Alts 3, 4, and 5*	*Same as Alts. 3 and 4 with additional considerations.* Operation of in situ biological system would require workers handling chemicals, and special precautions will have to be taken with oxygen and *methane* supply system to avoid potential for explosion.
• Time until remedial objectives are achieved[1]	*Remedial Objective 1A currently* met. Remedial Objectives 1B, 2A, 2B probably *never met. Contaminants* could reach Bailey Park wells in 10 years.	Portion of aquifer between existing and new purge well sys*tems may be remediated within* 12 years. Remainder of aquifer *would require an indefinite period* to reach *remedial* Objective 1B. *Soil remedial goals not met.*	Portion of aquifer between existing and modified blocking well systems may be remediated in 12 years. Portion of aquifer between new blocking wells and source areas may be remediated *in 20 to 30 years*. Groundwater at source areas will take more than 50 years *for remediation*	*Same as Alt 2 for portion of aquifer. Soil remedial* Objective 2A may be met within 2 years. Objective 2B *may be met within* 5 years; however, Objective 2B might never be met due to contaminant volatilization from groundwater. Time until groundwater objective 1B is met is likely to be more than 50 years	Both soil Objectives 2A and 2B may be met within approximately 1 year. Time until groundwater Objective 1B is met likely to be greater than 50 years	*Portion of aquifer between* blocking well systems remediated within 12 years. *Soil objectives met as in Alt 4.* Time until groundwater Objective 1B is met is 20 to 30 years.	Soil objectives may be met within approximately 1 year for Annex. *Groundwater objectives met as with Alt 6*	All remedial objectives at the Annex may be met within 4 to 10 years. Length of time may vary substantially depending upon results of bench and pilot scale testing, but will be less than time *required* for Alts 6 and 7. May still take 20 to 30 years to meet all *remedial objectives* at the paint shop. The aquifer between the blocking well systems *remediated* within 12 years
• Environmental impacts	Air stripper effluent discharged to the Battle Creek River. Water table has not been lowered substantially and nearby wetlands are not threatened.	*Same as Alt. 1*	*Same as Alt 1*	Minimal soil erosion expected during installation of treatment system. *Discharge of contaminants to river same as Alt 2.*	Mitigative measures needed to control runoff during excavation. *Discharge of contaminants to river same as Alt 2*	*Same as Alts. 3 and 4*	*Same as Alts. 3, 4, and 5*	*Same as Alts 3,4, and 5*

[1] Use time estimates for groundwater collection and treatment remedial actions only to compare alternatives

NOTE: Italics mean information is the same as or similar to information for other alternatives

Table 19 (continued)
DETAILED EVALUATION OF ALTERNATIVES
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

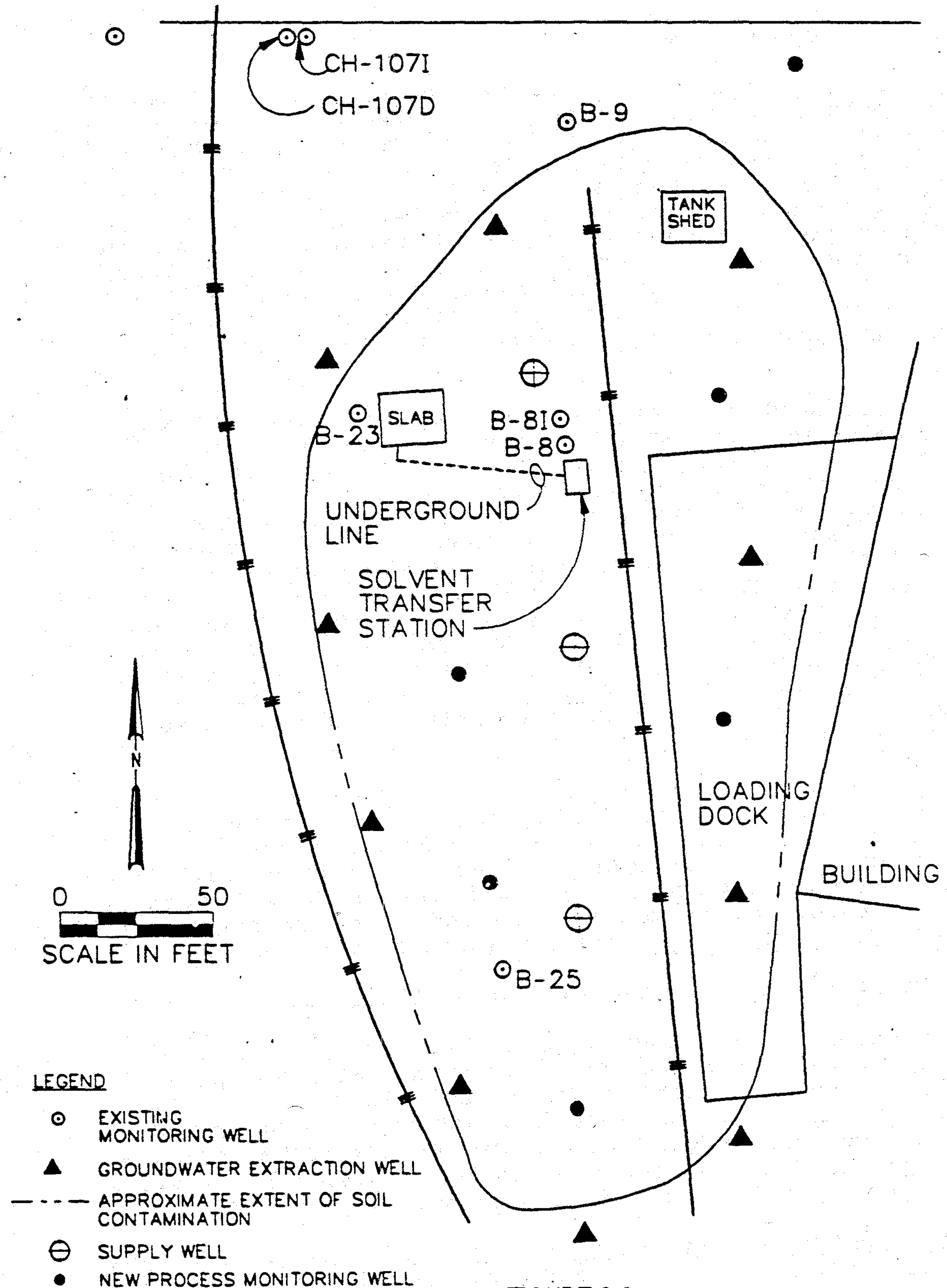


FIGURE 2.2
IN SITU BIOREMEDIATION WELL NETWORK
VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

1. Overall Protection of Human Health and the Environment

Alternatives 1 does not address current and potential future risks from soil and groundwater contamination at the sources and groundwater downgradient of the sources. Alternative 2 does address risks posed by groundwater downgradient of the sources, but does not provide protection from groundwater at the source areas. Alternative 3 addresses risks from groundwater contamination at both the sources and downgradient. Risks posed from source area soils would not be addressed by Alternatives 1, 2, or 3. Alternatives 4 and 5 would eliminate risks from contaminated soils and would address risks from downgradient contaminant plumes, however future potential risks from groundwater at the source areas would not be mitigated for several decades.

Alternatives 6, 7, and 8 address all current and potential future risks posed from soils and groundwater at the site.

2. Compliance With ARARs

Of the eight alternatives only those that contain both soil and groundwater remediation would meet ARARs. Alternative 8 may require a wavier of Michigan's Water Resources Commission Act to allow injection of nutrients into the groundwater. Alternatives 1 and 2 would not meet Federal and State ARARs for groundwater including Federal MCLs and Michigan Act 307 Rules, nor would they meet Act 307 for soil remediation. Alternative 3 would comply with groundwater ARARs, but would not meet Act 307 requirements for soils. Alternatives 4 and 5 would comply with Act 307 soil remediation requirements, but would not actively address groundwater contamination at the source areas and would, therefore, take several decades to meet MCLs and groundwater requirements of Michigan Act 307.

B. Primary Balancing Criteria

Five primary balancing criteria are used to identify major trade-offs between the remedial alternatives which satisfy the two threshold criteria. These trade-offs are ultimately balanced to identify the preferred alternative and to select the final remedy. Alternatives that do not satisfy the threshold criteria include Alternatives 1, 2 (by itself), and 3. These alternatives are not discussed further (except the combination of Alternative 2 with other alternatives).

1. Long-Term Effectiveness and Permanence

Alternatives 4 through 8, once completed, could reduce residual excess lifetime carcinogenic risks of contaminants associated with the soil and groundwater to below 1×10^{-6}. In the case of Alternatives 4 and 5, however, this would require an extended time period.

Alternatives 4 and 5 provide adequate and reliable controls for preventing exposure from contaminated soils but not from source area groundwater contamination. Alternatives 6, 7 and 8 would eliminate the need for control of contaminated soil or groundwater once the remedial action is completed. For soils this would be 1 to 5 years, and for groundwater approximately 20 years.

2. Reduction of Toxicity, Mobility, and Volume

Alternatives 4 through 8 treat contaminants in soils and groundwater and permanently destroy the contaminants thereby reducing toxicity. Groundwater treatment requires destruction of contaminants through regeneration of vapor/aqueous phase carbon. Contaminants in soils would be incinerated, or destroyed through regeneration of vapor phase carbon and/or catalytic oxidation. Alternatives 6, 7, and 8 provide for reduction of the greatest volume of contaminants because they treat the greatest volume of contaminated groundwater.

3. Short-Term Effectiveness

All of the alternatives are expected to be protective of the community and site workers during implementation and operation of the remedial action. The greatest potential risk to the community and site workers is with Alternatives 5 and 7, due to release of fugitive VOC emissions during excavation. Because groundwater remediation will take several years, there is also a potential for private well use during that time. Health advisories and/or temporary institutional controls may need to be implemented to prevent this.

Alternatives 4 through 8 could achieve the remedial objectives for the site (see Section VII). Alternatives 4 and 5 could both meet soil remediation objectives in one year for Alternative 4 and 2 to 5 years for Alternative 5. The groundwater objective for protection of the aquifer (Objective 1B) would eventually be met at the source areas but this would take several decades.

Implementing soil and groundwater remediation concurrently as with Alternatives 6, 7, and 8, would meet groundwater and soil objectives. However, Alternatives 6 and 7 require more than 20 years to achieve groundwater objective 1B. This is due to the continued desorption of contaminants from soil in the saturated zone. Alternative 8 includes bioremediation of the contaminated saturated zone soils. This would provide a reduction in time required to achieve cleanup goals in the groundwater at the Annex.

None of the alternatives are expected to have adverse environmental impacts. There is a potential impact associated with discharging water to the Battle Creek River. This impact is mitigated with treatment of the water prior to discharge, provided the treatment system(s) are maintained in proper working condition and in compliance with discharge limits. Effluent limits required by the MDNR are designed to protect aquatic life in the river. Because of the proposed location of the incinerator at the Annex, no impact to the environment would be expected from its operation.

4. Implementability

Soil vapor extraction, which is proposed for Alternatives 4, 6, and 8, has been successfully implemented at the Raymond Road source area. Implementation of SVE is not expected to pose any problems, but the length of operation is difficult to predict. Incineration, proposed for Alternatives 5 and 7, is a proven technology and is not expected to have implementation problems, however, there are significant technical and administrative requirements for setup and operation. Services and materials required to implement SVE, onsite incineration and groundwater extraction are widely available.

In situ biological treatment presents the most uncertainty with respect to its technical feasibility. This technology is considered innovative and its effectiveness has not been demonstrated for many of the contaminants present at the site. Implementation would require extensive bench- and pilot-scale testing to determine its feasibility, the residual concentrations it could achieve, and the time needed to achieve them. Services for bioremediation of chlorinated compounds may be limited due to the required expertise, which is offered by few companies.

Administratively, none of the alternatives, except Alternative 8, would have difficulties. Substantive requirements of discharge permits would have to be met for air and water discharges, and the incinerator would have to complete a test burn to demonstrate compliance with emission standards. Bioremediation would require permission from the State to inject the nutrients into the aquifer.

5. Costs

Costs for operation of the existing blocking wells and cost for Alternative 2 are included in the costs for Alternatives 4 through 8. Alternatives 5 and 7, which include incineration of contaminated soils, are significantly more expensive than Alternatives 4 and 6, which use soil vapor extraction. Alternative 8 is similar to Alternative 6, but is slightly more expensive because it includes in situ bioremediation.

C. <u>Modifying Criteria</u>

These two criteria reflect the comments and concerns of the State and the local communities on the alternatives presented to address the Verona Well Field site contamination.

1. State Acceptance

The MDNR has been the support agency for the RI/FS and has reviewed this record of decision. The MDNR concurs with the selected remedial action. However, the MDNR feels that modifications to the proposed SVE systems should be looked into prior to initiation of soil remediation at these source areas. In addition, MDNR does not feel that Alternatives 1 through 5 are protective or attain ARARs and therefore these alternatives would not be acceptable to it.

2. Community Acceptance

Several comments have been submitted by the community, local governments, and potentially responsible parties. In general, issues presented in the comments were directed toward the locations of the additional purge wells of Alternative 2, the results of the risk assessment, the process for determining clean up goals for the site, and the modeling used in the FS. In addition, there were several comments that proposed additional alternatives. Overall, most comments support the concept of SVE for soil remediation and continued operation of the existing blocking wells. However, the need for source area groundwater collection was questioned, as was the need for the additional purge wells.

D. Summary

Based on a comparison of the nine criteria, Alternatives 1, 2 and 3 do not provide protection from all of the potential risks at the site and do not comply with ARARs. Because these alternatives did not satisfy the threshold criteria, they were not evaluated against the remaining criteria. Alternatives 4 through 8 are protective and would attain ARARs.

Alternatives 6, 7, and 8 provide the greatest degree of long-term effectiveness and permanence because they provide the greatest degree of remediation of contaminants. All of the alternatives provide reduction of toxicity through destruction of contaminants, although Alternatives 6, 7, and 8 destroy a greater volume of contaminants.

Although all of the alternatives would be considered protective of the community during implementation and operation, Alternatives 5 and 7 have the greatest potential for community exposure to VOCs during excavation of contaminated soils. Alternatives 4 and 5 would attain soil cleanup goals in 5 years and one year respectively. However, under these alternatives, groundwater clean up would require more than 50 years. Alternatives 6 and 7 have similar time frames for clean up of soils, but because groundwater at the sources would be actively remediated, these alternatives would clean up groundwater in 20 to 30 years.

Implementation of SVE for Alternatives 4, 6, and 8 is not expected to pose any implementation problems. Incineration, proposed for Alternatives 5 and 7, would have significant technical and administrative requirements for implementation. Bioremediation has not been shown to be effective in the remediation of many of the compounds present at the Annex. Extensive testing would be required prior to start up and there would be numerous administrative requirements associated with injection of nutrients into the aquifer. In addition, there is a limited number of experts available who could perform the work.

Alternatives 5 and 7 are the most costly due to the incineration of contaminated soils. Costs for 6 and 8 are similar, and are somewhat greater than Alternative 4 which does not include groundwater remediation at the source areas.

The MDNR concurs with the selected remedy for the site, but does not consider Alternatives 1 through 5 to be protective or comply with ARARs and therefore would not accept any of these alternatives. The community, local governments and PRPs that submitted public comments concur with soil remediation at the sources and the continued operation of the existing blocking wells but differ on other aspects of the selected remedial action. Public comments received during the public comment period are addressed in the responsiveness summary of this ROD.

IX. REMEDIATION AT THOMAS SOLVENT RAYMOND ROAD

The Raymond Road remedial action was initiated as a result of a ROD in August 1985 that called for installation and operation of SVE and groundwater extraction systems to address soil and groundwater contamination at the Raymond Road source area. The previous ROD set interim clean up standards for soils, and postponed establishing clean up standards for groundwater. Final soil and groundwater clean up standards for the Raymond Road facility are the same as for other source areas and the groundwater plumes listed in section VII of this ROD (see Tables 16 and 17).

A. Conclusions of Performance Evaluation

As part of the ongoing remediation at the Raymond Road facility, a performance evaluation report was developed to report progress and evaluate potential enhancements to the ongoing remediation. Based on the report's conclusions, several alternatives were proposed for enhancement of both SVE and groundwater extraction systems.

The conclusions presented in the report are summarized below.

* The zone of influence of the groundwater extraction system does not extend downgradient to the livestock yard. High levels of contamination have been detected in monitoring wells in this area.

* Loading rates of the off-gases from the SVE system have decreased from greater than 1,000 pounds per day initially to least than 10 pounds per day currently.

* Soil samples collected in 1989 and 1991 indicate that soils contamination is now limited primarily to the smear zone (unsaturated zone/saturated zone interface) in the locations where floating product was detected previously. Results indicate that the majority of the VOC mass has been removed.

* The presence of NAPL (nonaqueous phase liquid) has created pockets of contamination in the pore spaces of the soils located in the smear zone that slowly release VOCs to the groundwater. These pockets of NAPL are difficult, if not impossible, to completely remove using conventional SVE and groundwater extraction methods and result in the plateauing of contaminant concentrations in groundwater which leads to prolonged operation of groundwater extraction systems without achieving cleanup goals.

* Transfer of VOCs from these pockets of NAPL in the soil pores occurs more readily to soil vapor than to groundwater.

* Results of the bench-scale study suggest that SVE should be able to remove the contaminants in soils, even with the NAPL pockets, if sufficient air/NAPL interface is created.

B. Alternatives

Based on these conclusions, six alternatives were developed and evaluated to determine if enhancements to the systems could be implemented that would expedite remediation of soils and groundwater. Thomas Solvent Raymond Road (hereinafter TSRR) Alternatives 1, 2, and 6 propose alterations to the existing systems and Alternatives 3, 4, and 5 propose the employment of new treatment technologies.

TSRR Alternative 1 - Intermittent Operation of the SVE and Groundwater Extraction Systems

This entails operation of the SVE wells and the groundwater extraction wells on an intermittent basis. The system would be turned off for several days or weeks and then operated for a given period of time. The objective would be to allow contaminants more time to diffuse into the soil vapor from the soil pore spaces. This would result in a lower volume of groundwater and soil vapor being extracted with greater concentrations of VOCs removed.

TSRR Alternative 2 - Modify the Existing SVE and Groundwater Extraction Systems

This alternative includes modification of the existing SVE and groundwater extraction systems. Modifications to the groundwater extraction system would include additional extraction wells in the area of the livestock yard to extend the zone of influence of the groundwater extraction system to include capture of the high concentrations of contaminants in this area. Modifications to the SVE system would include: 1) screening additional SVE wells in the lower few feet of the vadose zone to force air into this area; 2) installation of air injection wells screened in the lower portion of the vadose zone to introduce horizontal flow to this area; and 3) install dual extraction wells (extraction of groundwater and soil vapor from the same well). This technique provides for enhanced removal of contaminants from the saturated soils. Dual extraction wells lower the groundwater surface to expose more contaminated soils that can then be subjected to SVE.

TSRR Alternative 3 - Radio Frequency Heating of the Soil

This alternative employs thermal energy to increase the rate of VOC removal from the soil by raising the temperature of the soil. This allows for increased volatilization of contaminants, and provides the energy required to overcome the forces holding the NAPL in the soil pore spaces.

TSRR Alternative 4 - Steam/Hot Air Injection

Steam injection is similar to SVE with the exception that pressurized steam is injected into the soil. Once injected, steam condenses and mobilizes lower boiling point contaminants and aids in the volatilization of higher boiling point contaminants. Contaminants are recovered in the extraction wells in both liquid and vapor phases and are treated using condensation, distillation, and vapor phase carbon.

TSRR Alternative 5 - Steam/Hot Air Injection With In Situ Soil Mixing

This alternative combines steam injection with physical mixing of the soil. Physical mixing is accomplished using a large drilling tower with two augers that mix the soil. As soil is mixed, hot air and steam are injected in to the soil. The steam and hot air volatilizes VOCs and they are then carried to the surface where they are treated as described in TSRR Alternative 4.

TSRR Alternative 6 - Groundwater Aeration

With groundwater aeration, compressed air or nitrogen is sparged into the saturated zone to remove VOCs in the saturated zone. As air moves through the pore spaces, it displaces the groundwater which causes contaminants to volatilize into the air or soil vapor and is extracted by the SVE system.

Table 20
Summary of Evaluation of Remedial Options

Alternative	Description	Effectiveness	Implementability	Cost
Alternative 1	• Intermittent operation	• Limited	• Easy to implement	• None
Alternative 2	• SVE system modification	• Most contaminants removed in 2 to 3 years	• Easy to implement	• $10 to 15 per yard
Alternative 3	• Radio frequency heating	• 90 percent contaminant removal after 1 year	• Technically very complex • Would require detailed review from State regulators	• $75 per yard
Alternative 4	• Steam/hot air injection	• Unproven but most contaminants probably removed in 1 year	• Moderately complex • Regulatory concern about migration of steam and organic liquids	• $50 per yard
Alternative 5	• In situ soil mixing	• 90 percent contaminant removal after 1 year	• Technically complex • Would require detailed review from regulators	• $100 to $300 per yard
Alternative 6	• Groundwater aeration	• Shown to be effective on a few sites	• Easy to implement • Regulatory concern about air injection into aquifer	?

[a]No additional cost; about 10 percent decrease in current operating cost.

Note: Costs listed above are in addition to the costs already incurred at the site. The costs do not include expenses associated with construction oversight, permitting, or verification sampling.

C. Summary of Evaluation of Alternatives

The alternatives were evaluated based on effectiveness, implementability, and cost. Table 20 presents a summary of the evaluation.

1. Effectiveness

Intermittent operation of the extraction systems under TSRR Alternative 1 would increase VOC concentrations in the soil vapor but would probably not hasten removal. In fact, it could slow the rate of removal due to a decrease in the concentration gradient between soil vapor and adsorbed VOCs which would decrease the rate of diffusion to soil vapor. Intermittent operation of the groundwater extraction system is not expected to have any effect on rate of contaminant removal from the saturated zone, nor has experience shown any increase in removal rates by the SVE system following shut down of the groundwater extraction system.

TSRR Alternative 2 has the potential to significantly increase the effectiveness of the SVE and groundwater extraction systems by providing quicker release of contaminants from soils through air injection and dual extraction. Additional groundwater extraction wells would significantly reduce the time required to reach groundwater cleanup goals in the aquifer.

TSRR Alternative 3 would likely be very effective at removing contaminants from the vadose zone. Field data suggests a greater than 90 percent removal efficiency. However, this technology would not remove contaminants in the saturated soils, and thus would not decrease cleanup times for the groundwater.

Like TSRR Alternative 3, TSRR Alternative 4 would be effective in removing contaminants from the vadose zone, but would not address contamination in the saturated soils. Some SVE vendors have experienced difficulty in operation of steam injection due to condensing steam clogging pore spaces.

TSRR Alternative 5 would likely provide the quickest and most effective means of completing remediation of the vadose zone. Based on current field data, site remediation could be completed within a year after implementation.

TSRR Alternative 6 provides for removal of contaminants in the saturated soils and may also be effective in removing VOCs from the capillary fringe.

2. Implementability

No technical or regulatory involvement is required for TSRR Alternative 1. TSRR Alternative 2 would require additional well installations for both soil and groundwater extraction systems and additional piping. Installing additional extraction wells and/or dual extraction wells would require modifications to the existing pumping system for groundwater. No new regulatory requirements would be required.

Technical and regulatory implementation issues of TSRR Alternative 3 are expected to be complex. Application of this technology would be the first full-scale demonstration of this technology. In addition, it is not clear if the technology is commercially available. TSRR Alternative 4 would require less complex technical and regulatory requirements than TSRR Alternative 3, but would require a demonstration that the injected steam could be controlled. Implementation of TSRR Alternative 5 would have similar requirements as TSRR Alternative 3. There are several issues that would need to be resolved and could result in a 2 to 3 year delay in implementation. TSRR Alternative 6 would be relatively easy to implement although it would probably require pilot testing to determine radius of influence of injected air.

3. Costs

Cost savings for TSRR Alternative 1 may not be significant because the system maintenance and analytical costs would remain unchanged. SVE operating cost savings would be offset by the increased costs associated with turning the system on and off. Additional cost of implementation and operation of TSRR Alternative 2 for 2 years of operation is estimated to be about $400,000.

TSRR Alternative 3 is estimated to cost approximately $2,800,000. This cost is based on pilot-scale operation and could increase substantially for permitting and engineering oversight. The preliminary cost estimate for TSRR Alternative 4 is approximately $2,200,000. TSRR Alternative 5 has an estimated cost of $7,400,000, and could be much more based on permitting requirements and engineering oversight. There is limited cost information available for TSRR Alternative 6. However costs are expected to be approximately $40,000 for well installation and it is assumed that operation costs would be similar to the air injection portion of TSRR Alternative 2.

D. Summary

TSRR Alternative 1 may not be acceptable due to the requirement to turn off the groundwater extraction system. There are no cost savings and no decrease in operating time. Since the report concluded that SVE should be able to remove contaminants from the vadose zone with enhancements, TSRR Alternatives 3, 4, and 5 are not justified because they do not address the saturated soils and are very expensive to operate for a reduction in operation time of 1 to 2 years over conventional SVE. TSRR Alternative 2 provides enhancements to the effectiveness of the SVE system at a lower cost, is implementable, and would provide some enhancement to the site.

The risk assessment identified 48 chemicals of potential concern for the site. Of those, 18 chemicals were identified as indicator chemicals for groundwater and 14 chemicals were identified as indicator chemicals for soils. These indicator chemicals (listed in Tables 16 and 17) are the primary compounds, with the exception of arsenic, found during the risk assessment to present individual risks greater than 1 x 10E-6 increased carcinogenic risk or a risk ratio of greater than one. Since other compounds were identified (the remaining chemicals from the list of 48 not identified as indicators) at the site, periodic sampling will be required to ensure that none of the remaining chemicals are exceeding ARARs. Sampling for these chemicals will be required at a minimum of once every two years. Table 21 lists the Act 307 Type B cleanup numbers for all 48 chemicals of potential concern. These numbers would be utilized as action levels for compliance with Act 307, an ARAR for the site.

One of the goals of this remedial action is to restore groundwater to its beneficial use, which is, at this site, a drinking water source. Based on information obtained during the RI/FS, U.S. EPA believes that the selected remedy will achieve this goal. It may become apparent, during implementation or operation of the groundwater extraction system that contaminant levels have ceased to decline and are remaining constant at levels above the cleanup goals for the site in some portion of the plumes. In such a case, the system performance standards and/or the remedy may be reevaluated.

The selected remedy calls for groundwater extraction for a period of 20 to 30 years, during which the system's performance will be carefully monitored on a regular basis and adjusted as warranted by performance data collected during operation. The remedial design will specify the sample locations, sample frequency, analytical parameters, and reporting requirements for the monitoring program.

The final remedy incorporates the ongoing interim actions at the site as part of the site remediation. Based on conclusions of the Performance Evaluation Report [for] Thomas Solvent Raymond Road Operable Unit, April 1991, the final remedy also includes the following additional and/or continued remedial actions at the Thomas Solvent Raymond Road source area:

- Continued operation and maintenance of the groundwater extraction system including installation of additional groundwater extraction wells;

- Installation of a treatment system for extracted groundwater; and

- Implementation of a groundwater monitoring program.

Table 21

Michigan Act 307, P.A. 1982, as Amended
Type B Cleanup Numbers: 6/20/91

COMPOUND	GROUNDWATER (ug/l)	SOILS(ug/kg)
Carcinogenic:		
Benzene	1	20
1,2-Dichloroethane	0.4	8
n-Nitroso-di-n-propylamine	0.005	0.1
Trichloroethene	3	60
Vinyl Chloride	0.02	0.4
Noncarcinogenic:		
Acetone	700	14,000
Antimony	3+	60+
Barium	2000+	40,000+
Benzoic Acid	30,000	600,000
Benzylbutylphthalate	1000	20,000
Bromomethane	10	200
2-Butanone	400	8000
Cadmium	4+	80+
Carbon Disulfide	700	10,000
Chlorobenzene	100	2000
Chromium (total)	100	2000
Copper	1000+	20,000+
Dibutylphthalate	700	10,000
Diethylphthalate	6000	100,000
Ethylbenzene	70	1400
Manganese	700	10,000
Mercury (inorganic)	2+	40+
2-Methylphenol	40	800
4-Methylphenol	400	8000
4-Methyl-2-Pentanone	400	8000
Naphthalene	30	600
Nickel	100+	2000+
Nitrobenzene	4	80
Phenol	4000	80,000
Toluene	800	16,000
Trans-1,2-Dichloroethene	100	2000
1,1,1-Trichloroethane	200	4000
Tetrahydrofuran	200	4000
Vanadium	*	*
Xylenes	300	6000
Zinc	1000+	20,000+

Table 21
(continued)

Michigan Act 307, P.A. 1982, as Amended
Type B Cleanup Numbers: 6/20/91

COMPOUND	GROUNDWATER (ug/l)	SOILS(ug/kg)
Both Carcinogenic and Noncarcinogenic:		
Arsenic	0.02+	0.4+
Beryllium	*	*
Bis (2-ethylhexyl) phthalate	2	40
Bromodichloromethane	0.3	6
Carbon Tetrachloride	0.3	6
Chloroform	6	100
1,1-Dichloroethane	700	10,000
1,1-Dichloroethene	7	100
Hexachloroethane	2	40
Methylene Chloride	5	100
Tetrachloroethene	0.7	10
1,1,2-Trichloroethane	0.6	10

\+ If local background is greater than these health-based criteria, local background can be used as a final cleanup goal.

* No Type B cleanup numbers have been developed for vanadium and beryllium; therefore, Type A numbers will be used for these compounds. This number is being developed and will be provided when developed.

Note: In lieu of meeting soil cleanup numbers, a leachate test may be performed as specified in Michigan Act 307, for Type B cleanups.

remediation of the groundwater. TSRR Alternative 6 looks to be the most effective technology for the saturated soils, and it would provide some enhancement to remediation of the vadose zone.

X. SELECTED REMEDY

This section presents the selected remedy for the final operable unit at the Verona Well Field Superfund site. Section 121 of CERCLA requires that all remedies for Superfund sites be protective of human health and the environment, comply with ARARs, be cost-effective, and utilize permanent solutions and alternate treatment technologies to the maximum extent practicable. Alternative 6 is believed to provide the best balance of trade-offs among alternatives with respect to the nine criteria set forth in the NCP for evaluation of alternatives. Based on the evaluation of the alternatives, U.S. EPA and the State of Michigan believe that Alternative 6 will be protective, attain ARARs, be cost-effective, and will utilize permanent solutions and alternate treatment technologies to the maximum extent practicable.

The selected remedy for the final operable unit entails:

1 - Continued operation of the existing blocking wells and air stripper in the Verona Well Field;

2 - Installation and operation of additional purge wells downgradient of the source areas, and groundwater treatment (utilizing air stripping with vapor phase carbon) for extracted groundwater;

3 - Collection and treatment (utilizing air stripping with vapor phase carbon) of contaminated groundwater at the Thomas Solvent Annex and Grand Trunk Marshalling Yard Paint Shop source areas;

4 - Installation and operation of soil vapor extraction systems to remediate contaminated soils at the Annex and Paint Shop sources areas; and

5 - Implementation of groundwater, soil, surface water discharge, and air monitoring programs to monitor the treatment systems.

The response objectives and cleanup goals for the final remedy are presented in Section VII of the ROD. Response objectives include continuing to limit groundwater contamination at the Verona Well Field production wells to levels that do not pose a health hazard, reducing contamination in the affected aquifer and in all source area soils to levels that meet cleanup goals, and preventing additional contamination of groundwater above cleanup goals through leaching of contaminants from soils. Cleanup goals developed for the final remedy are listed in Tables 16 and 17. The selected remedy will achieve the response objectives and cleanup goals for

This additional groundwater action is based on TSRR Alternative 2 of the performance report which is discussed in Section IX of the ROD. TSRR Alternative 2 proposed enhancements to the SVE system as well as the groundwater extraction system, however, only the groundwater portion of TSRR Alternative 2 will be incorporated into the final ROD. SVE enhancements will be addressed by the current actions on-going at Raymond Road. A pilot test for the SVE enhancements evaluated in TSRR Alternatives 2 and 6 is currently in the planning stages.

In accordance with the preference for innovative treatment technologies and to ensure the most expeditious clean up at the site, emerging in situ treatment technologies shall be evaluated as to their effectiveness in addressing VOCs in saturated and unsaturated soils. The evaluation will focus on whether any such technologies have the capability of reducing contamination in the saturated and/or unsaturated soils such that cleanup time is reduced or the ability to achieve cleanup goals is enhanced.

XI. STATUTORY DETERMINATIONS

The selected alternative for the Verona Well Field, as outlined above, meets the statutory requirements set forth in Section 121 of CERCLA, in that it is protective of human health and the environment, attains ARARs, is cost-effective, utilizes permanent solutions and treatment technologies or resource recovery technologies to the maximum extent practicable and has a preference for treatment as a principal element as described below.

A. Protection of Human Health and the Environment

The selected remedy addresses risks posed from all of the pathways identified in the risk assessment for the site. Remediation of groundwater at the sources and downgradient in the aquifer will reduce the potential excess lifetime cancer risk for ingestion of, inhalation of, and dermal exposure to contaminated groundwater to 1×10^{-6} throughout the aquifer. Furthermore, the hazard index for risks from noncarcinogens in groundwater at the Thomas Solvent Raymond Road source area will be reduced to less than one. Remediation of source area soils will reduce the potential excess lifetime cancer risk from inhalation of contaminants in soils by future onsite workers to 1×10^{-6}.

Implementation of the soil and groundwater remedial actions at the source areas and in the downgradient aquifer, as called for in the selected remedy, will not pose any unacceptable short-term risks or cross-media impacts to the site, the community, or the onsite workers.

B. Compliance with ARARs

The selected remedy, which is the final remedy for the entire site including the modifications to the prior Thmas Solvent Raymond Road operable unit, will comply with all Federal, and more stringent State, applicable or relevant and appropriate requirements (ARARs) of environmental laws. The following is a discussion of the major ARARs which the selected remedy will attain. Additional ARARs can be found in other documents in the administrative record.

1. Chemical-Specific ARARs

Chemical-specific ARARs include those laws and requirements that regulate the release of contaminants to the environment.

Federal

Maximum Contaminant Levels (MCLs) and non-zero Maximum Contaminant Level Goals (MCLGs) are the Federal drinking-water standards promulgated under the Safe Drinking Water Act (SDWA), and are applicable to municipal water supplies serving 25 or more persons. MCLs and non-zero MCLGs are relevant and appropriate for the Verona Well Field site since the affected groundwater at the site is a drinking water supply.

Secondary MCLs established under the SDWA are designed to control contaminants in drinking water that effect the aesthetic qualities of drinking water, and are nonenforceable under the federal regulations.

Section 304 of the Clean Water Act (CWA) establishes Ambient Water Quality Criteria (AWQC) for protection of human health and aquatic life. The AWQC are considered relevant and appropriate at Superfund sites where a release or the threat of release is present or when remedial actions require point source discharges. Since treated water will be discharged to the Battle Creek River, AWQC are relevant and appropriate for the discharge.

No Federal chemical-specific standards exist for soils.

State

The Michigan Environmental Response Act 307, P.A. 1982, as amended, and associated rules (Act 307) and administrative rules promulgated under the act provide for the identification, evaluation, and remediation of environmentally contaminated sites within the State. Therefore, the U.S. EPA considers substantive portions of Parts 6 and 7 of Act 307 to be an ARAR for the remedial action at this site. Under Act 307, all remedial actions must be protective of public health, safety, welfare, and the environmental and natural resources of the State. To achieve protectiveness, Act 307 specifies that remedial actions shall achieve a degree of cleanup under either Type A (cleanup to background levels), Type B (Cleanup to risk based levels), or Type C (cleanup to risk-based levels under site-specific considerations) criteria.

The U.S. EPA has determined that acceptable standards for soil and groundwater cleanup, that have been derived under type B criteria, would be protective for groundwater and soils at the site. Cleanup levels derived under Type B criteria would allow the aquifer to be restored to its beneficial uses by achieving the risk-based cleanup standards the U.S. EPA has determined will assure protection of human health and the environment.

Portions of the Water Resources Commission Act 245, P.A. 1929, as amended, (Act 245) establish surface water quality criteria standards to protect human health and the environment. The State administers the NPDES program under Part 21 of Act 245. Therefore, Part 21 of Act 245 would be applicable to the direct discharge of treated water to the Battle Creek River or to the indirect discharge through groundwater movement to a surface water body.

The Michigan Air Pollution Control Commission Act 348, P.A. 1965, as amended, (Act 348) establishes standards for ambient air quality and emissions. Compliance with Act 348 requires attainment of an incremental carcinogenic risk concentration of 1×10^{-6} and one percent of the threshold limit value concentration for noncarcinogens. The substantive requirements of Act 348 are considered applicable to air discharges as a result of the selected remedial actions.

2. Location-Specific ARARs

Location-specific ARARs are those requirements that relate to the geographical location of the site.

Federal

Both RCRA (40 CFR 264.18(b) - hazardous waste storage - flood plain) and Executive Order 11988 - Protection of Flood Plains, are relevant and appropriate for this site, since the well field is adjacent to the Battle Creek River. These regulations require placement of groundwater treatment systems in the well field be above the 100-year flood plain. The Endangered Species Act of 1973 is also a location-specific ARAR for the site.

State

The Hazardous Waste Management Act 64, P.A. 1979, as amended, (Act 64) regulates the generation, transport, treatment, storage, and disposal of hazardous waste. A more specific discussion of the siting provisions of Act 64 is set forth in the responsiveness summary.

3. Action-Specific ARARs

Action-specific ARARs are requirements that define acceptable treatment and disposal procedures for hazardous substances.

Federal

Since the Thomas Solvent Company operated waste storage facilities that resulted in release of contaminants to the environment after 1980, RCRA is applicable for the Raymond Road and Annex source areas, and wastes contained in soils and groundwater from releases that originated from these facilities are RCRA-listed wastes. The release of contaminants from the Grand Trunk Paint Shop occurred prior to 1980, so RCRA is relevant and appropriate for contaminated soils and groundwater resulting from release of hazardous substances from that source area. Since the TSC facilities were RCRA regulated storage facilities, closure regulations under RCRA Part 264 Subparts I and J (264.178 and 197) are applicable. The remedy complies with the requirements for closure because treatment of soils with SVE will be equivalent to "clean closure." Closure and post closure requirements for storage facilities are regulated under RCRA Part 264 Subpart G. The remedy complies with substantive requirements pertaining to closure (264.111, 264.112 and 264.113). In addition, corrective action requirements of Part 264 Subpart F will be met for the entire site to the extent they are applicable or relevant and appropriate. Since spent carbon from the treatment systems will be shipped off-site to be regenerated, Land Disposal Restrictions (Land Ban) apply to the extent that notification must be made to the treatment facility that the wastes are RCRA-listed. The remedy does not include "placement" of wastes under Land Ban.

State

The State of Michigan is authorized to administer RCRA within the State. Under the Hazardous Waste Management Act 64 (Act 64) the State regulates the generation, transport, treatment, storage, and disposal of hazardous waste. Pertinent portions of Act 64 that are more stringent than RCRA Subtitle C would be applicable for the Verona Well Field site.

C. Cost-Effectiveness

Cost-effectiveness compares the effectiveness of an alternative in relation to its cost of protecting human health and the environment. Alternative 6 is the least costly alternative that provides protection from all identified current or potential future pathways of exposure from contaminated soils and groundwater at the site.

D. Utilization of Permanent Solutions and Alternate Treatment Technologies to the Maximum Extent Practicable

U.S. EPA believes the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner for the Verona Well Field site. Of the alternatives that are protective of human health and the environment and comply with ARARs, U.S. EPA has determined that the selected remedy provides the best balance of trade-offs in terms of the five balancing criteria (long-term effectiveness and permanence, reduction in toxicity, mobility and volume achieved through treatment, short-term effectiveness, implementability, and cost), and also considering the statutory preference for treatment as a principal element and considering State and community acceptance (modifying criteria).

Once the alternatives satisfied the threshold criteria, the key criteria used in remedy selection were short-term effectiveness, implementability, and costs. Alternatives 4 and 5 require the longest time for groundwater remediation to cleanup goals because they do not address groundwater contamination at the sources thus delaying contaminant removal until it has moved downgradient. Alternatives 5 and 7, which include soil incineration, are much more costly than the Alternatives 4, 6, and 8, without providing any additional protection. Alternative 8 proposed a technology that is untested for treatment of the contaminants found at the site.

The State of Michigan concurs with the selected remedy. The community supports portions of the remedy and has submitted comments regarding the proposed action which are included in the responsiveness summary attached to this ROD.

Since Alternative 6 utilizes permanent treatment technologies for remediation of both groundwater and soils and will require destruction of contaminants during treatment, and because it is less costly than incineration and is a proven technology previously used at this site, it is considered to provide the best balance of trade-offs with respect to the nine criteria and represents the maximum extent to which permanent solutions and treatment are practicable.

E. Preference for Treatment as a Principal Element

The selected remedy satisfies the statutory preference for treatment as a principal element. The principal threat to human health is from the soils at the source areas. The remedy will treat the soils as well as groundwater, which is a primary pathway of exposure. Since Alternative 6 utilizes permanent treatment technologies for remediation of both groundwater and soils and will require destruction of contaminants during treatment the preference for treatment is satisfied.

XII. DOCUMENTATION OF SIGNIFICANT CHANGES

The Proposed Plan for the Verona Well Field site was released for public comment in February 1991. In the Proposed Plan, U.S. EPA identified Alternative 2 as an alternative to implement an additional line of blocking wells at the southern boundary of the well field. The objectives of the new blocking wells were to provide protection from contaminant migration to the production wells on the west side of the Battle Creek River in Bailey Park, provide additional protection to the main well field east of the river, and to restore the portion of the well field between the existing blocking wells and the new blocking wells.

During the public comment period, several comments expressed concern about the proposed locations of the new wells. Members of the community in which three of the wells were to be located, expressed strong objections to the placement of the wells there. In addition, consultants for Grand Trunk and a citizen of the community expressed concern over the potential for contaminants to be drawn further into the residential area due to the placement of the extraction wells. Consultants for Grand Trunk were also concerned about the overall effectiveness of the extraction wells based on their placement so far downgradient from the sources and proposed that wells be placed in the axes of the plumes. This would allow for removal of contaminants closer to the source where concentrations are higher.

Based on these concerns and the alternate proposals received, U.S. EPA has modified Alternative 2. Alternative 2 now entails placement of downgradient purge wells to address protection of Bailey Park and the main well field, and to restore groundwater in the well field south of the existing blocking wells. Placement of the extraction wells will be determined during the design of the remedial action based on meeting these objectives, but will also be based on the concerns expressed during the public comment period. The decision on optimum placement of the wells, to be made by U.S. EPA in consultation with the State, will be aided by the use of groundwater modeling during the design. Considerations will include the relocation of wells originally planned for the residential area southwest of the well field, and the placement of one or more purge wells in the area of highest contamination concentration downgradient of the Annex (the selected remedy also calls for additional extraction wells downgradient of the Raymond Road facility).

ATTACHMENT I

RESPONSIVENESS SUMMARY

VERONA WELL FIELD
BATTLE CREEK, MICHIGAN

Introduction

The United States Environmental Protection Agency (U.S. EPA) and the Michigan Department of Natural Resources (MDNR) have completed the final Remedial Investigation and Feasibility Study (RI/FS) at the Verona Well Field Superfund site in Battle Creek, Michigan. During the RI/FS, U.S. EPA and MDNR collected information on the nature and extent of contamination at the source areas and well field, evaluated alternatives for appropriate remedial action at the source areas and well field, and proposed a final remedial action for the entire site. Throughout the investigation process at the site, U.S. EPA and MDNR have held several meetings and availability sessions to discuss site progress and receive comments and questions from the public. At the conclusion of the FS, U.S. EPA and MDNR finalized a proposed plan for the final remedy which identified the recommended alternative for remedial action at the site. U.S. EPA offered a 99-day public comment period on the FS and proposed plan from February 15, 1991 to May 24, 1991. At a public meeting on March 12, 1991, U.S. EPA presented its proposed plan and accepted public comments on the proposal.

The RI/FS has been undertaken under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, and the National Contingency Plan (NCP), as amended. Under CERCLA, comments received from the public are considered in U.S. EPA's selection of the remedial action for each site. This document summarizes comments received during the public comment period and indicates how the comments were considered in the selection of the remedial action for the Verona Well Field site.

The responsiveness summary has three sections:

I. Overview. This section briefly outlines the U.S. EPA's proposed plan for remediation at the site.

II. Community Involvement. This section provides a brief history of community interest and concerns raised during remedial planning activities at the site.

III. Summary of Public Comments Received During Public Comment Period and U.S. EPA Responses. Comments received are organized by persons submitting the comments and grouped by issue, and followed by U.S. EPA responses to the comments.

The detailed transcript of the proposed plan public meeting and the written comments are not included in the report. They are available for public inspection in the administrative record located in the public repository at the Willard Library in Battle Creek, Michigan.

I. Overview

On February 15, 1991, U.S. EPA made available to the public for review and comment the FS report and U.S. EPA's proposed plan for remedial action at the Verona Well Field site. The proposed plan presents 8 alternatives evaluated for remediation of the site and U.S. EPA's preferred alternative which entails:

- Continued operation of the existing blocking wells and air stripper in the Verona Well Field;

- Installation and operation of additional purge wells downgradient of the source areas, and groundwater treatment for the extracted groundwater;

- Collection and treatment of contaminated groundwater at the Thomas Solvent Annex and Grand Trunk Marshalling Paint Shop source areas;

- Installation and operation of soil vapor extraction systems for remediation of contaminated soils at the Annex and Paint Shop sources areas; and

- Continued operation and maintenance of the groundwater extraction system at Thomas Solvent Raymond Road, including installation of additional extraction wells;

- Installation of a treatment system for extracted groundwater at the Thomas Solvent Raymond Road source area; and

- Implementation of groundwater, soil, surface water discharge, and air monitoring programs to monitor the treatment systems.

U.S. EPA received several comments from the public at the public meeting in Battle Creek, and received several additional written comments from the public, local governments, State Agencies and the potentially responsible parties (PRPs).

II. Community Involvement

Community interest in the problems at the Verona Well Field site has been very intense at certain periods during the progression of activities at the site. The community has expressed concerns over exposures to residents from private wells and the need for a clean water supply. U.S. EPA and MDNR have held several meetings and maintained frequent communication with the community, local officials, and members of the State Legislature and U.S. Congress to resolve issues and discuss concerns. Fact sheets were prepared by MDNR periodically to keep the community updated on site progress. A total of 20 progress reports were issued between 1983 and 1987.

In November 1983, U.S. EPA held a kickoff meeting to discuss the RI work to be performed. A public comment period was held on the focused feasibility study (FFS) for remedial measures at the well field between March 29, 1984 and April 12, 1984. Copies of the FFS were made available to the public at the start of the comment period. A public meeting was conducted on April 5, 1984, and public comments received throughout the comment period were evaluated before finalization of the ROD in May 1984.

Following completion of the phased feasibility study (PFS) for remediation at the TSRR facility, U.S. EPA published the document and began a public comment period that ran from June 17, 1985 through July 20, 1985. A public meeting was held to present results of the PFS and to solicit public comments. After consideration of public comments, the ROD was finalized in August 1985.

During the period from 1987 through 1990, U.S. EPA and MDNR held three separate availability sessions to discuss progress regarding the ongoing remedial actions at the site.

In November 1990, the community applied for a Technical Assistance Grant (TAG) to hire a technical assistant to help them review site documents prepared for the final remedial action. The TAG was awarded to the community in December 1990.

The final RI report was released to the public in August 1990. The public comment draft of the FS for the final remedy and the proposed plan (PP) for site cleanup were released February 15, 1991. This signaled the start of a 60-day public comment period. A public meeting was held on March 12, 1991 to present the findings of the FS and to accept comments on the FS and PP. The public comment period was scheduled to close April 15, 1991. However, U.S. EPA extended the public comment period to May 24, 1991 as a result of an extension request by one of the PRPs.

III. <u>Summary of Comments Received During Public Comment Period and U.S. EPA's Responses</u>

The public comments regarding the Verona Well Field site are organized into two categories:

- Summary of comments from the community, local governments, and State agencies; and

- Summary of comments from PRPs plan.

Many of the comments submitted were paraphrased in order to effectively summarize them in this document. Also, a number of comments were submitted during the public comment period that are not relevant to the selection of the remedy and are not significant comments, criticisms, or new data regarding the proposed plan. Therefore, in accordance with Section 117(b) of CERCLA, it is not appropriate to respond to such comments in this responsiveness summary. Such comments will be included in the administrative record for the site.

<u>Summary of Community, Local Government, and State Agencies Comments</u>

Comments were received from the community and several local governments orally during the public meeting and in writing during the remainder of the public comment period.

- Several comments expressed concern about the proposed locations of the new purge wells and asked that the wells not be placed in the residential area southwest of the well field. In addition, many citizens asked that plans for the additional wells and piping take into consideration the residents and their properties.

Based on these concerns and others, U.S. EPA has modified the proposed plan. The selected remedy ensures that no purge wells will be placed on residential properties. However, there may be a need to place at least one well on the perimeter of the residential area either in the vicinity of Emmett and Brigden Roads (along the railroad tracks) or adjacent to the river. The final locations of the wells will be determined during the remedial design. U.S. EPA will make every effort to avoid locating pipes and digging trenches in the residential neighborhood. Consideration will be given to the residents when planning and implementing the remedy; however, there may be the possibility of activity along the perimeter of the residential area depending on where the purge wells are located.

- Two comments were made with regard to the location of the additional air strippers called for in the proposed remedy. One comment indicated that Michigan Law prohibits the placement of treatment facilities within 2,000 feet of a municipal well.

Michigan's Hazardous Waste Management Act 64 requires that <u>new</u> waste treatment facilities be located a minimum of 2,000 feet from a municipal well. For the siting of an air stripper, this portion of Act 64 would not be relevant and appropriate for the reason that the purpose of this remedial action is to remedy an already contaminated water supply. U.S. EPA is unclear as to why there would be opposition to placement of this additional air stripper at the well field. The cited portion of Act 64 is meant to restrict contamination of clean water supplies by preventing the handling of waste in the proximity of municipal wells. However, in this case, the restrictions on siting new facilities would not be relevant or appropriate because the treatment system may be placed at the well field to remedy an already contaminated water supply.

The final locations for the air strippers have not yet been determined, and it is not certain whether any of the strippers will be located within 2,000 feet of the municipal wells. The specific locations of the strippers will be determined during the remedial design.

- One comment asked where the piping for the downgradient purge wells will be located.

Because the exact location of the purge wells has not been determined at this time, the locations of piping for the wells have also not been determined. This information will be determined during the design.

- Several comments were received from the community, local governments, and the Michigan Department of Public Health (MDPH) regarding U.S. EPA's proposal to use treated water from the existing blocking wells in the City's water supply. Three comments were in support of using the treated water; however, one of the comments suggested that we include aqueous phase carbon treatment following air stripping to "polish" the water, and another of the comments asked that adequate sampling be conducted to ensure quality. The City of Battle Creek and other local government bodies expressed opposition to use of the water in the City's distribution system.

As discussed at the public meeting, U.S. EPA believes that groundwater is a very valuable resource and should be preserved rather than wasted, if there is a means of using it. The proposal to reuse the treated water is based on this ideology. However, the City of Battle Creek is not willing to accept the treated water for its water supply, and thus U.S. EPA cannot go forward with this plan at this time.

- One citizen commented that the proposal to place extraction wells in the residential area would result in pulling the contaminant plumes farther into this area.

U.S. EPA acknowledges this concern and, based on this as well as other concerns, has determined that purge wells will not be located in the residential area downgradient of the Annex facility (see response to Issue 1B below).

- One comment stated that the neighborhood south of Raymond Road and the Raymond Road Landfill is not addressed in the FS even though contamination was found in this area.

U.S. EPA acknowledges that low levels of contaminants have been found in monitoring wells downgradient of the Raymond Road landfill. However, it has been determined that the contaminants migrating from the landfill are not contributing to the contamination of the Verona Well Field. For further discussion see response to Issue 5 below.

- One comment stated that the risk assessment is faulty due to its narrow view of what the chemicals of concern are on the site. The comment also stated that by not including the landfill and ignoring heavy metals the risks at the site are understated.

The Risk Assessment conducted for this site initially considered all 73 compounds detected during RI sampling. This list was reduced to 48 chemicals of potential concern based on frequency of detection (compounds detected in less than 5 percent of the samples were eliminated) and availability of toxicity information (compounds were eliminated if no toxicity information was available). The 48 chemicals of potential concern include volatile and semivolatile compounds and metals. The risk numbers presented in the risk assessment include the risks from all 48 chemicals of potential concern. The calculations of risk are presented in Appendix B of the RI Report.

The Raymond Road landfill is not currently affecting the Verona Well Field and is being addressed under a separate State action (see response to Issue 5 below).

- One comment asked why the public doesn't have input into developing alternatives. The comment further questioned U.S. EPA's hiring practices for contractors and stated that U.S. EPA's contractor seemed to be making the decisions regarding planning and cleanup for the site.

U.S. EPA hires contractors with expertise in the field of hazardous waste investigations and remediation. U.S. EPA does not feel it would be prudent to allow members of the public without this expertise to perform this type of work. U.S. EPA's contractor, CH2M Hill, was hired following the Federal Acquisition Regulation (FAR) which specifies the requirements for the acquisition of architect-engineer services. U.S. EPA has been satisfied with the work that has been performed at this site by CH2M Hill and has retained CH2M Hill as a contractor in the Superfund program based largely on its overall performance. However, CH2M Hill is not responsible for making decisions concerning investigation and cleanup at this site or any site and has not made those decisions at this site. That is and has been the responsibility of the U.S. EPA. Furthermore, the FAR requires that periodic audits be performed by the Office of Inspector General of U.S. EPA and a final audit at completion of the contract by the General Accounting Office (GAO).

- One comment suggested that bioremediation be considered due to its potential to expedite cleanup even though it costs slightly more.

U.S. EPA considered bioremediation for removal of contaminants at the Annex as a means of expediting cleanup of groundwater; however, bioremediation has not been shown to be effective in breaking down many of the contaminants found at this site (see response to Issue 7 below).

- One comment asked why it has taken so long to begin cleanup of the site.

The process for studying and cleaning up a Superfund site is very lengthy and requires several years to complete. However, at the Verona Well Field site, U.S. EPA and the State have taken several actions to protect the well field and the residents, including implementation of the blocking well system, hookups to City water for affected homes, temporary bottled water to affected residents, and the start of cleanup of the most severely contaminated source area.

- A comment expressed concern regarding the safety practices of the contractors working at the Raymond Road facility and questioned whether such practices are endangering workers and the community.

U.S. EPA is not aware of any unsafe practices by its contractors at the Raymond Road facility. Each of the contractors is required to follow a safety plan that identifies risks from site contaminants and other hazards, and air sampling is conducted to ensure that no offsite releases occur during onsite activities. A copy of the safety plan and work plan for the work being conducted presently has been put in the site repository at the Willard Library in Battle Creek.

- A petition was submitted with several signatures that asked for relief from payment of monthly water bills by the homes that were hooked up to city water due to private well contamination and suggested that U.S. EPA apply monies recovered from the responsible parties to pay for the residents' water bills.

Under the Superfund program, U.S. EPA is charged with cleaning up hazardous waste sites and protecting people from exposure to dangerous chemicals released from these sites. Whenever private wells are threatened or contaminated, U.S. EPA looks to State and local governments for assistance in providing safe drinking water. In the case of the Verona Well Field, the City of Battle Creek has provided drinking water to residents under provisions of Michigan's Environmental Response Act 307. Unfortunately, Act 307 does not provide for payment of water bills for affected residents.

Money that has been recovered by U.S. EPA is for costs incurred for response activities to study the site, protect the well field, and begin cleanup at the Thomas Solvent Raymond Road facility. Under the Superfund law, monies recovered from responsible parties at Superfund sites must be put back into the general funding for use at other Superfund sites.

- One comment stated the U.S. EPA was in violation of the CERCLA requirement that ATSDR (Agency for Toxic Substances and Disease Registry) perform a health assessment at the Verona Well Field site.

It is true that CERCLA requires that all Superfund sites have a health assessment completed. However, the preliminary health assessment is used to determine whether there are health risks caused from site contaminants and to determine if further followup health activities are indicated. For Verona Well Field, a health study has already been completed by MDPH through a cooperative agreement with ATSDR. ATSDR has also actively reviewed site documents for this site since 1983, and has tasked MDPH to perform an updated health assessment based on the most current data reported by U.S. EPA.

- One comment expressed concern over lack of detail in the FS and stated that it made it difficult to comment on the FS and proposed plan.

The FS is not intended to be a design, but an engineering study to determine the feasibility of implementing various alternatives to clean up the site. What U.S. EPA is asking is that the public submit comments on the concept involved for the various alternatives.

- A comment was received that said that the risk assessment is faulty because it states that the plume is not draining into the river.

Water level measurements collected as part of the remedial investigation (RI) showed that above (north) the Emmett Street dam, groundwater levels are generally lower than the level of the river and the river is recharging the groundwater. Below the dam (south), the opposite is true, and shallow groundwater discharges into the river. Monitoring wells located south of the dam were sampled as part of the RI and showed little or no contamination. There is currently no evidence that shows that any of the contaminant plumes are discharging into the river.

- One comment asked for the reason that data collected before 1989 were not included in the RI report.

Analytical data from the Verona Well Field site are available from sampling events conducted in 1982 to the present. However, analytical methods, detection limits, sample collection, and custody procedures have changed since 1982, and consequently more current data are assumed to have greater accuracy. In addition, the conditions at the site have changed considerably over the 9 years it has been studied. In order to generate more accurate, up-to-date, and defensible data, it was decided not to use any of the pre-RI (data collected before 1988) for any quantitative purpose in the RI or Risk Assessment. Data from before 1988 were used in qualitative analyses, like the selection of sample locations and for the tracking of plume movement.

- Two comments questioned why the FS only addresses 12 chemicals when the RI identified 48 chemicals in need of cleanup from over 70 found at the site.

The FS presents cleanup objectives for 18 chemicals found in the groundwater and 12 chemicals detected in the soil at the site. Although 48 chemicals of potential concern were found, indicator chemicals are identified based on frequency of detection and level of detection. These are the primary compounds, with the exception of arsenic, found during the Risk Assessment to present individual risks greater than a one in one million increased carcinogenic risk or a risk ratio of greater than one. Arsenic occurs naturally in the groundwater at this site and was not considered for remedial action.

- Two comments asked why there is no allowance made for the dangers of living over the plume in an area with porous, sandy soils and high water tables.

The exposure pathways evaluated for current and future residents at the site included consumptive and nonconsumptive uses of groundwater. The ingestion of contaminated groundwater was the only exposure route quantified because it is generally more easily quantified and defensible than inhalation risks. Risk estimates for the residential ingestion pathway assume the consumption of 2 liters of contaminated groundwater each day for 40 years. This assumption is more conservative and correspondingly more protective than one for an inhalation pathway would have been.

- One comment stated that the FS has a total disregard for human life.

The FS addresses risks to human health identified during the site Risk Assessment by setting cleanup objectives for soils and groundwater at the site at levels of 10^{-6} increased carcinogenic risk and hazard index ratios of less than one. Soils found at the source areas and all affected groundwater are addressed through these cleanup objectives. These cleanup objectives and the exposure pathways they address were developed in accordance with the NCP, Section 300.430.

- Two comments claimed that the risk assessment is faulty in that it does not include information from residential soil sampling.

There is no indication that residential soils are or have been contaminated due to the contamination identified at the Annex, Thomas Solvent Raymond Road, or Paint Shop source areas. Because the residential soils are not part of a plausible exposure pathway, it did not make sense to evaluate them as part of the risk assessment.

- One comment noted that air monitoring costs were not included in the FS.

Air monitoring costs were only included for Alternatives 5 and 7 which involved excavation of the contaminated soils. If it is determined that air monitoring is required during implementation (for trenching, etc.) of other alternatives, the cost estimates will be revised.

- One community member submitted modifications to the proposed alternative.

These modifications have been considered and are addressed under U.S. EPA's response to Issue 8 below.

<u>Summary of PRP Comments</u>

The PRPs submitted several volumes of comments prepared by technical consultants and attorneys retained by the PRPs. Three different consultant/attorney "groups" representing Thomas Solvent Company, Grand Trunk Western Railroad, and the seven Annex defendants submitted comments. Comments are grouped into eight different issues, with various concerns identified for each issue. A summary of specific comments is included with each of the issues. The responses to the eight main issues include:

Response 1:	The U.S. EPA's positions on the current and future use of the Verona Well Field (Response 1A) and justification for additional blocking wells (Response 1B)
Response 2:	The U.S. EPA's position on considering the site for an Act 307 Type B cleanup
Response 3:	The U.S. EPA's approach to setting cleanup objectives at the site
Response 4:	The U.S. EPA's position on the feasibility of the proposed plan ever meeting the required cleanup criteria
Response 5:	The U.S. EPA's approach to other sources of groundwater contamination around the well field
Response 6:	The U.S. EPA's response to technical comments regarding the groundwater modeling
Response 7:	The U.S. EPA's response to specific comments pertaining the development and analyses of alternatives in the FS
Response 8:	The U.S. EPA's consideration of other proposed alternatives.

RESPONSE 1A

U.S. EPA's position regarding the current and planned use of the Verona Well Field.

- One comment suggested that increased pumping at the Verona Well Field after contamination was discovered has exacerbated the extent of the groundwater plume.

The suggestion that increased pumping at the Verona Well Field after contamination was discovered has exacerbated the extent of the groundwater plume is not realistic in light of the situation at the Verona Well Field. U.S. EPA's responsibility at Superfund sites is to protect human health and the environment. In the case of the Verona Well Field, actions were taken to stop contamination from entering the production wells in the well field. This was accomplished by implementing the blocking well system currently in operation at the well field. U.S. EPA took action to protect the well field because it is the source of drinking water for the City of Battle Creek, with a population of more than 35,000, and implementing the blocking wells was determined to be the most cost-effective alternative for providing a long-term source of clean drinking water for the City. Without the blocking wells, all of the City's production wells would have eventually become contaminated.

- One comment stated that the selected remedy should provide for additional capacity for the City for future growth, and one comment stated that the selected remedy should not provide for increased capacity due to recent water demands from the cereal industry in Battle Creek.

The provision for additional capacity for the City to accommodate future growth was not a consideration in developing and evaluating the alternatives for remedial action. In fact, it is U.S. EPA's policy not to provide for any future growth when designing remedial actions for Superfund sites. It is U.S. EPA's position that any increase in pumping, or other actions, in the well field by the City that results in failure of the blocking wells to protect the well field will be the responsibility of the City. This includes any increased pumping to respond to increased water demands from the cereal industry in Battle Creek.

- One comment stated that restoring the well field to its original size is not a stated objective of the FS.

Although restoring the well field to its original capacity was not a stated objective in the FS, it is an objective of the FS to restore the entire affected aquifer. Placing purge wells at the southern boundary of the well field will result in cleanup of the groundwater within their zone of influence in an accelerated time period and will provide further protection to the well field from the contaminant plumes.

- One comment asked that the feasibility of using treated water from the current blocking wells for potable uses instead of discharging it to the Battle Creek River be looked at by U.S. EPA.

The feasibility of using treated water from the current blocking wells for potable uses instead of discharging it to the Battle Creek River has been evaluated by U.S. EPA and was included as part of the proposed cleanup plan for public comment. U.S. EPA feels that the use of the treated water would be a beneficial use of the water and would preserve a natural resource. However, the City of Battle Creek has made the decision not to accept the treated water for distribution within its water supply. Without the consent of the City, U.S. EPA cannot go forward with this plan.

- One comment stated that the City of Battle Creek has considered the possibility of moving the well field because of numerous sources of contamination including other sources than those addressed under Superfund.

The possibility of moving the well field because of numerous sources of contamination including other sources than those addressed under Superfund was not considered as part of the FS. U.S. EPA has not been informed of consideration of any such actions. If the City of Battle Creek were to move its well field, the goals of the remedial action would need to be reevaluated to determine whether the selected remedy is appropriate in light of this change.

RESPONSE 1B

There were a number of comments questioning the need for new blocking (purge) wells, given the U.S. EPA's position on current and planned uses of the well field. As identified in the FS, additional purge wells are needed to provide overall protection of the western portion of the well field and more rapid and effective restoration of the southern portion of the well field as well as restoration of the downgradient plumes. The placement of the wells in the FS report was done primarily for evaluation purposes. The ROD provides for a degree of flexibility in well placement based on guidelines for overall well field protection.

Specific comments are as follows:

- A number of comments questioned whether the screening of remedial alternatives adequately considered either the existing or a modified blocking well system.

In developing the FS, three possibilities were considered: retaining the existing blocking well network without modification, modifying the existing blocking wells, and constructing additional purge wells. The first was retained as the no-action alternative. The other two alternatives were then evaluated for implementability, effectiveness, and cost.

The implementability and cost of both alternatives were considered to be about equal. The development of additional purge wells was selected as Alternative 2, based on the greater extent of overall protection they could provide the Verona Well Field, and in particular the production wells in Bailey Park, and the more rapid and effective restoration of the aquifer in the area between the source areas and the well field.

- Several comments were received that stated there is no evidence that the limited detection of chemicals in samples from behind the existing blocking wells represents a failure of the blocking system.

While it cannot be stated for certain that the periodic detection of cis-1,2-DCE in Verona production wells V-13 and V-36 represents a failure of the blocking well system, the locations of these wells and the corresponding concentrations of cis-1,2-DCE in the nearby blocking wells V-22, V-24, V-25, and V-26 indicate that the compound may be migrating beyond the existing blocking wells.

The detection of cis-1,2-DCE at 7 ppb in well V-36 in July 1988 can likely be attributed to the shutdown of the blocking wells for 3 weeks due to a valve failure and the subsequent flooding of the air stripping treatment system dry well.

It is also not plausible that other source areas are the cause of the periodic contaminant breakthrough, since the only known contaminant sources within the zone of influence of the well field that were not addressed by the FS are petroleum product UST (underground storage tanks) sites that do not contain 1,2-DCE. However, it has been speculated that the contaminants found are a result of residual contamination from the previous occurrence of the plumes extending farther into the well field (prior to implementation of the blocking wells).

- Several comments suggested that enhancing the existing blocking well system would have resulted in the most cost-effective remedial alternative.

Enhancements of the existing blocking well network was considered during the initial development of the alternatives as an alternative to the construction of additional blocking wells. It was not carried further into the alternative development process because the need to add additional wells to protect the Bailey Park production wells resulted in present worth cost estimates that were essentially equal for the two options. In addition, adding any new wells to the current system would require additional air stripper capacity. Providing additional purge wells was selected for inclusion in the FS because it provided greater overall protection of the entire well field and more rapid and effective restoration of the affected aquifer.

- One comment suggested that the reliance upon the existing blocking well system as a no-action alternative, without examining ways to upgrade the system, is inconsistent with the NCP.

The NCP requires the development and evaluation of a range of remedial alternatives, so that EPA can select an appropriate remedy for the site. Section 300.430(e)(2) of the NCP states:

> "Alternatives shall be developed that protect human health and the environment by recycling waste or by eliminating, reducing, and/or controlling risks posed through each pathway by a site. The number and type of alternatives to be analyzed shall be determined at each site, taking into account the scope, characteristics, and complexity of the site problem that is being addressed."

One of these alternatives is to be the no-action alternative as described in Section 300.430(e)(6) of the NCP:

> "The no-action alternative, which may be no further action if some removal or remedial action has already occurred at the site, shall be developed."

Upgrading the existing blocking wells was considered in the initial scoping of alternatives, but was not carried forward in the development of alternatives because it was judged to be less effective at providing overall protection and restoration of the well field. EPA finds no inconsistency with the NCP on this point.

- A comment was received that questioned why the alternatives were not evaluated without the new purge well system.

Alternative 2, as presented in the FS, focuses on the overall protection of the Verona Well Field. Groundwater modeling carried out as part of the FS showed enhancement of the present blocking well network to be necessary in providing overall protection to the well field. As a result of this evaluation, it was decided that it was necessary to include Alternative 2 with the remainder of the alternatives in order to have alternatives that achieve protection.

- A comment was received stating that the purported justification for the new purge well system is contradicted by statements located elsewhere in the FS that the existing blocking wells are already achieving cleanup objective 1A.

While the existing blocking well network appears to be achieving Remedial Objective 1A in the northern portion of the well field, groundwater modeling carried out in support of the FS showed that contaminant breakthrough around the western edge of the blocking well network is possible in the future, given current pumping conditions. Given the potential for breakthrough, additional purge wells are needed to provide long-term effective protection to the northern and western portions of the well field, and to restore the southern portion of the well field.

- Two comments questioned the statement on page 5-12 of the FS that with continued pumping of the Bailey Park wells, contaminants from the Annex may migrate around the western edge of the existing blocking well system.

Computer modeling of the well field and surrounding area showed that under existing pumping conditions, the potential exists for contaminants to migrate around the western edge of the existing blocking well network and contaminate the Bailey Park wells, and possibly the main well field. This modeling is presented in Appendix D of the FS.

- A comment was received that questioned why the FS did not consider increasing the pumping rate of the existing blocking wells.

The existing blocking wells are limited by the treatment capacity in the present air stripping treatment system (2,000 gpm). While increasing the pumping rates in conjunction with a new expanded treatment system could have been investigated, the existing blocking well system still would not have been able to protect the western portion of the well field from possible contamination. Increasing the extraction well pumping rates also would not restore any more of the affected aquifer.

- Two comments questioned how EPA could justify the installation of a new blocking well system based on the detection of 1,2-DCE in downgradient wells.

The justification for additional purge wells was not based on the detection of 1,2-DCE in production wells V-13 and V-36, but rather on projections of future contaminant migration, the results of computer modeling of the site, and on the desire for remediation of a greater portion of the affected aquifer than is currently undergoing remediation.

Modeling projections based on current municipal pumping conditions showed that compounds from the existing contaminant plumes south of the well field could migrate around the western edge of the current blocking system. Therefore, modifications to the blocking well system were deemed necessary to adequately protect the city well field.

In addition, while the existing blocking wells function to protect the northern portion of the well field, they do not address the southern portion of the well field or the remainder of the affected aquifer.

- Two comments were received stating that the location of purge wells in the Darlene/Kimball neighborhood may have the effect of accelerating the movement of the contaminant plume towards and beneath that neighborhood.

U.S. EPA has acknowledged that this may indeed happen and as a result of this concern (and others) has modified Alternative 2 in the ROD to specify that no new wells will be placed within the boundaries of the neighborhood. Additional wells will likely be installed to protect the Bailey Park municipal wells. Wells will also be installed in the area between the neighborhood and the source areas to provide greater containment and treatment of the plumes as they leave the source areas and more effective restoration of the affected aquifer.

- One comment suggested that a series of monitoring wells and a regular monitoring program be implemented to provide an early warning of the initiation of breakthrough of the existing blocking wells.

An effective monitoring program for tracking the migration of the contaminant plume is advantageous and necessary in providing adequate well field protection. However, in the case of the Bailey Park wells and the western portion of the main well field, groundwater monitoring showed that contaminants were close to the Battle Creek River in 1989. Given the rapid movement of groundwater in this aquifer system, it would be unwise not to provide purge wells to protect Bailey Park now, and to monitor the effectiveness of those wells.

- One comment stated that Alternative 2 will face a greater risk of breakthrough than the existing blocking wells due to the higher concentrations of contaminants at the location of the new purge wells.

Despite the fact that they have been used as blocking wells since 1984, the wells that make up the existing blocking well network were originally designed, constructed, and operated as potable water production wells. As production wells, they were not spaced as closely together or drilled as deeply as blocking wells may have been. Consequently, although the concentrations of contaminants are likely to be greater at the locations of the new wells, the new wells are expected to be more effective through placement and construction than the existing wells at capturing the contaminant plumes.

The additional purge wells as proposed in the ROD will capture the majority of contaminants in the plumes migrating from the source areas, thereby restoring a greater portion of the affected aquifer and providing a greater reduction in contaminant volume and mass over a shorter period of time than would be possible solely with the existing blocking wells. The existing blocking well network, modified to protect Bailey Park, will continue to capture contaminants downgradient of the new purge wells.

RESPONSE 2

Comments frequently suggested that the site should not be considered for a Type B cleanup and that a Type C cleanup was more applicable and realistic given the site conditions. Specific comments are addressed below.

- Two comments suggested that the Type B standards are not an ARAR because they are not promulgated as defined in Section 300.400(g) (4) of the NCP.

The Michigan Environmental Response Act 307 of 1982, as amended (Act 307), is a promulgated State law that provides for the identification and evaluation of contaminated sites within the State. Accordingly, Act 307 is either applicable or relevant and appropriate to the Verona Well Field site, and the substantive portions of the Act 307 rules that apply to site remediation (Parts 6 and 7) must be followed, in lieu of a waiver, during the remedial action at this site.

According to Section 300.400(g)(4) of the NCP which describes the applicability of state standards, a state standard must be legally enforceable and of general applicability in order for it to be considered an ARAR.

In order to be legally enforceable a state law must be issued in accordance with state procedural requirements and contain specific enforcement provisions or be otherwise enforceable under state law. Act 307 rules, which are codified to M.A.C. Rule 299.5101, have been issued in accordance with state procedural requirements. Specific enforcement provisions for Type B criteria have been established by using standardized exposure assumptions. Type B cleanup criteria are based on reduction of hazardous substance concentrations to an acceptable risk level (i.e., 1 x 10^{-6} for carcinogens). If Type B criteria are less than the Method Detection Limits then the Method Detection Limit is the cleanup goal. These specific enforcement provisions parallel the U.S. EPA policy to reach an acceptable risk of 1 x 10^{-6} individual excess cancer risk in order to protect human health and the environment.

General applicability, as referenced by the NCP, requires that potential state ARARs be applicable to all remedial situations described in the requirement, not just CERCLA sites. Act 307 Type B cleanups have been applied across the State of Michigan according to the criteria outlined in the Act 307 Rules. Cleanup criteria applied to Type B sites are hazardous substance concentrations that do not pose an unacceptable risk on the basis of standardized assumptions and acceptable risk levels. The risk factors follow those presented within the U.S. EPA Risk Assessment Guidance for Superfund, December 1989.

- Three comments stated that other Superfund sites in Michigan have been classified as Type C and therefore there has been an inconsistent application of the type cleanups in Michigan. One of the comments suggest that this inconsistency is due to the practice of using the latest toxicological data available at a site as a basis for Type B cleanups.

As specified in Act 307, the application of Type A, B, or C cleanup in the State of Michigan is made on a case-by-case basis, considering the site-specific information. The Type B cleanup objectives at the site are justified because of the current and future use of the groundwater downgradient for public and private water supply, the rate and direction of groundwater movement, and the overall mobility and toxicity of the contaminants. The cleanup goals set under a Type B cleanup will allow the aquifer to be returned to beneficial use by achieving the risk-based standards consistent with the U.S. EPA risk assessment and chemical specific ARARs. The U.S. EPA finds no inconsistency in the application of cleanup goals by the State of Michigan or in the application of cleanup goals identified for this site.

- Three comments stated that the MDNR never gave a Type C cleanup due consideration at Verona.

The U.S EPA agrees with the State of Michigan that Type C cleanup objectives are not appropriate for this site given the current and future use of groundwater migrating from the source areas. The U.S. EPA policy under the Safe Drinking Water Act (SDWA) is to restore groundwater resources to beneficial use where practical. The target residual risk under the SDWA is consistent with a Type B cleanup.

Type C criteria have been applied to sites where, due to the nature and extent of contamination, the availability of technologies for remediation of the contaminants, and the location of the site and its surroundings, the use of containment or institutional controls is the most appropriate way to eliminate all the exposure pathways considering the factors in Act 307 and the NCP.

RESPONSE 3

A number of comments were received relating to the selection of chemical-specific cleanup objectives. Specific comments are as follows:

- Several comments suggested that cleanup levels and alternative performance standards were based on factors that are not ARARs.

U.S. EPA does not base cleanup levels solely on ARARs. The cleanup objectives presented in the FS are based on acceptable human health-based risk levels, MCLs, MCLGs, and Michigan Act 307 Cleanup Objectives in accordance with the NCP, Section 300.430(e)(2)(i). This approach is compatible with U.S. EPA's policy. Michigan Act 307 rules are promulgated in the State of Michigan and are considered ARARs at this site. Rules 299.5709 and 299.5711 of Act 307 address compliance with Type B cleanup criteria for groundwater and soils, respectively.

- A number of comments questioned the apparent absence of institutional controls to prevent installation and use of residential wells in the contaminated aquifer and to prevent direct contact with contaminated soils. One comment went on to say that U.S. EPA failed to adaquately cosider institutional controls, which is contrary to language in Section 300.430(a)(iii) of the NCP.

For groundwater, there are no laws available within the State of Michigan to prevent the use of an existing well for domestic water supply. Health advisories to warn citizens against the use of an existing well are the strongest measure available. Because there are currently wells in the contaminated aquifer, there is no means of controling their use.

For source area soils, Section 300.430(a)(iii) of the NCP prohibits the use of institutional controls in lieu of active response measures:

> "The use of institutional controls shall not substitute for active response measures (e.g., treatment and/or containment of source material, restoration of ground waters to their beneficial uses) as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of remedy."

Because the property on which the sites are located is currently in private ownership, and because the contaminants in the soil would continue to cause groundwater objectives to be exceeded, deed restrictions were not considered to be effective.

- One comment suggested that a survey be conducted to determine if there are private well users. If there are none, the groundwater pathway should be eliminated.

Risk assessment guidance does not allow for elimination of specific pathways based on current use if the potential for completion of the pathway in the future can not be guaranteed. At the Verona Well Field site, there is no available mechanism for the prevention of groundwater use within the residential neighborhood, despite the availability of the municipal water supply, and the insurance of health advisories.

- A number of comments questioned why cleanup levels corresponding to risks in the 1E-4 and 1E-5 range were not considered.

The NCP requires that the 10^{-6} risk level be used for determining remediation goals at sites with multiple contaminants and exposure pathways (NCP 300.430(e)(2)(i)(A)(2)). Also, Michigan Act 307 rules, ARARs for this site, require cleanup objectives corresponding to 10^{-6} risk levels for soils and groundwater at Type B sites (See discussion under response No. 2 for applicability of Type B cleanup). For these reasons, only 10^{-6} risk levels were considered in setting the cleanup objectives for this site.

- Three comments questioned why the groundwater cleanup objectives for benzene, chloroform, 1,2-dichloroethane, 1,1-dichloroethane, cis-and trans-1,2-dichloroethene, ethylbenzene, tetrachloroethene, toluene, trichloroethene, vinyl chloride, and xylene are below MCLs and/or MCLGs.

The NCP requires that cleanup objectives be protective of human health and the environment by considering federal and state ARARs and appropriate exposure pathway risk levels. Cleanup objectives that are more stringent than ARARs may be set when ARARs are not available, or are determined to be insufficiently protective due to multiple contaminants and multiple exposure pathways. Cleanup objectives for this site consider risk potential and Act 307 objectives as well as the MCLs and MCLGs.

- A number of comments stated that the cleanup objectives in the FS appear to be the result of a risk assessment that considers exposures and calculated risks far beyond what is expected and associated with the site.

The cleanup objectives presented in the FS consider contaminant exposure through groundwater and soil ingestion. Given the presence of a contaminated groundwater plume beneath a residential neighborhood, and the potential for excavations at or near the sites due to their industrial nature, the selected pathways are considered to be reasonable and justifiable.

- One comment questioned why there is no comparison between the risk levels calculated by the risk assessment in the RI and the risk levels associated with chemical-specific ARARs listed in the FS.

The two documents in question have separate purposes. The risk assessment, completed as part of the site's Remedial Investigation, calculated the risk from several exposure pathways at the site using chemical data obtained from the site. This was done to evaluate the need for additional remedial action. The risk levels presented in the FS used the same exposure pathways to identify the cleanup objectives for the site. The risk levels used to calculate the cleanup objective for the exposure pathways are a one in a million (10^{-6}) increased cancer risk for carcinogenic compounds and a hazard index of less than one for noncarcinogenic compounds. These levels are set by EPA to be protective of public health. The cleanup goals are also based on chemical-specific ARARs (i.e., MCLs, MCLGs, and Act 307). Cleanup goals were determined based on the more restrictive of the two.

- Two comments were received stating that the rationale for the selection of cleanup goals for compounds that have both carcinogenic and noncarcinogenic cleanup goals is not apparent. One of these comments also stated that the process for determining the average concentrations and their significance is unclear.

For all compounds, the lowest (most restrictive) of the chemical-specific ARARs or the carcinogenic/noncarcinogenic risk is designated as the cleanup objective. This is done to ensure compliance with the ARARs and so that the alternative is protective of human health. The chemical-specific ARARs include carcinogenic and noncarcinogenic risk numbers, MCLs, MCLGs, and Michigan Act 307 Type B cleanup numbers.

The average concentration presented in Chapter 3 of the FS is provided solely for comparative purposes. The averages were determined by summing the positive values for the samples where the compounds were detected, and adding one half of the detection limits for each sample where the compounds were not detected. The total value was then divided by the number of samples.

- Two comments asked why the potential for different risks at different soil depths was not evaluated. One of the comments added that soils deeper than 2 feet below ground surface are normally not considered to pose a risk due to ingestion.

As stated in the Remedial Investigation Report, the surface soils (0 to 2 feet) at the Annex and Paint Shop sites are not considered to be a health risk, primarily because of the volatile nature of the contaminants and length of time since the site has been active. Should trenching be used, the remainder of the vadose (unsaturated) zone would be treated as one unit because of the relatively small size of the zone (10 to 12 feet). Risks due to ingestion, inhalation, and dermal contact were evaluated in the Risk Assessment. Only the most stringent of these, ingestion, was evaluated in the FS.

- One comment asked why the risks associated with the groundwater protection concentrations on page 3-7 are not reported.

The soil cleanup objectives presented in FS Table 3-2, page 3-7, under the heading of Groundwater Protection correspond to the chemical concentrations in a soil matrix that would be expected to leach into the groundwater at concentrations exceeding the 10^{-6} excess lifetime carcinogenic risk for groundwater based on ingestion. The actual risk numbers for soil ingestion at these concentrations have not been assessed.

- One comment requested the reference for the document where U.S. EPA has determined that the entire aquifer is a compliance point, as stated in the FS on page B-5.

The preamble to the NCP (55 FR Page 8753) discussed the application of Section 300.430 (e)(2)(i)(A) which specifies the standards for location of point of compliance for groundwater cleanuo standards. For the purpose of the Feasibility Study, it was assumed that the identified cleanup objectives must be met in the entire aquifer in accordance with ARARs relating to the potential use of the aquifer (MCLs, MCLGs, and Michigan Act 307). The actual compliance monitoring points for the selected remedy will be determined during remedial design.

- One comment stated that remedial objectives 1A and 1B are not practical because water to the consumer must be below the cleanup objectives but not necessarily all water in the aquifer.

Where groundwater is or may be used directly for drinking water, MCLs and nonzero MCLGs are relevant and appropriate remediation goals to be met in the groundwater itself. This is the case at this site, given the locations of the contaminant plumes, residential neighborhood, and city well field. In addition, both EPA and the State of Michigan (through Act 307) have identified the entire aquifer as the compliance zone for groundwater remedial objectives.

- One comment said that the FS is inconsistent with Section 300.400(g) of the NCP because it does not identify the health-based cleanup levels contained in Proposed Corrective Action Regulations as potential ARARs for soil remedial objectives at the site.

Proposed regulations like the one identified above are not ARARs because they may change before being promulgated as final rules. However, proposed rules may be considered as "to be considered" criteria where they are useful in developing remedial objectives. At this site, health risks based on ingestion exposure pathways, MCLs, MCLGs, and state ARARs (Michigan Act 307) were used in setting cleanup objectives. There is no inconsistency with Section 300.400(g) of the NCP.

- One comment suggested that the remedial objectives in the FS are quite basic, almost generic, because they do not take advantage of available site-specific details.

The remedial objectives presented in the FS were developed based upon site characteristics and site ARARs. Primary considerations used in the development of the remedial objectives were the locations and use of residential and municipal groundwater wells, the lack of available regulations to prohibit the use of contaminated residential wells, and the state ARAR, Michigan Act 307, which through a Type B cleanup objective seeks to return the site to beneficial use.

- One of the comments stated that the FS objectives bar consideration of soil containment because soil containment does not reduce contamination.

Soil containment (capping) was considered in the FS (pages 4-16 and 4-17), but not retained for alternative development because capping would not prevent the further migration of contaminants from the soil, particularly the smear zone, to the groundwater. Soil containment is also inconsistent with a Michigan Act 307 Type B remediation plan, which seeks to return the site to beneficial use. Act 307 is a state ARAR for this site. Type B cleanup objectives have been identified as appropriate for remediation of this site.

- Two comments stated that the cancer risk cleanup goals should be recalculated to take into consideration the updated EPA guidance on exposure factors contained in OSWER Directive 9285.6-03, March 25, 1991.

The cleanup objectives contained in the Record of Decision (ROD) have been revised to take into account the updated EPA guidance on exposure factors as contained in OSWER Directive 9285.6-03, March 25, 1991. Please refer to Tables 16 and 17 of the ROD.

- One comment questioned the use of TCLP leachate procedures to set soil cleanup goals and a second comment stated that soil cleanup criteria should be based on actual leachate data.

TCLP procedures were used to estimate soil concentrations for the prevention of further groundwater contamination at the site. Because TCLP was developed by EPA to determine the mobility of contaminants in liquid, solid, and multiphase wastes, this is a valid estimating technique. The estimated concentrations are likely conservative in that it is assumed that 100 percent of the contaminant will leach into the groundwater in 20 volumes of water. However, this assumption may be close to the actual situation, given the sandy, nonorganic nature of the site soils. TCLP is also used in the Michigan Act 307 rules, an ARAR at this site, for setting soil remediation goals. Under Act 307, site-specific leaching tests may be considered as the basis for demonstrating achievement of soil cleanup goals.

- One comment asked for the reason that data collected prior to 1989 were not included in the RI report.

This comment was addressed above under Summary of Community Comments.

- One comment questioned the assumption made in the risk assessment that contaminants will persist at the same concentrations downgradient as at the exposure point, since this does not take into consideration natural degradation.

While it is likely that natural degradation will decrease the concentrations of groundwater contaminants downgradient of the source areas, there are currently no reliable methods for determining the extent of degradation over a given time or distance. Furthermore, some degradation products of chlorinated VOCs are more toxic than the original contaminant. Consequently, the conservative approach of assuming no degradation was used in conducting the Risk Assessment. It should be pointed out, however, that this assumption had no bearing on the selection of risk-related cleanup objectives in the Feasibility Study.

RESPONSE 4

Issue 4 pertains to the feasibility of meeting the soil and groundwater cleanup objectives. The comments noted that in view of the EPA's experience in remediation at Thomas Solvent Raymond Road, and in view of other technical literature published by the U.S. EPA, that the low cleanup objectives at the source areas may never be achieved. Thus the cleanup objectives should be waived as an ARAR. Related to this was the concern that cleanup goals were placed below the U.S. EPA method detection limit for several VOCs.

- Several comments stated that groundwater and soil cleanup goals are too low and that current technologies can not be expected to achieve the cleanup goals. Many comments suggested that new, more attainable, cleanup goals be established. One comment went on to say that groundwater extraction at the source areas should not be required because cleanup objectives could not be met, and one comment questioned whether U.S. EPA's approach was consistent with the NCP.

U.S. EPA acknowledges that research into groundwater pump and treat remedies have suggested that, in certain instances, low level cleanup goals cannot be achieved. Uncertainty in meeting cleanup objectives is an insufficient reason for not initiating groundwater extraction. At a minimum, implementing groundwater extraction would remove most of the dissolved contaminant mass at the source areas in a relatively short period of time as has been the case at many other sites documented by the U.S. EPA. Progress toward cleanup will be evaluated after the groundwater extraction systems are implemented and, if it is determined that cleanup objectives cannot be achieved, consideration will be given to establishing alternative concentration limits (ACLs).

However, until it is shown that the selected technologies can not achieve cleanup goals for this site, the remedy must be designed to be protection of human health and the environment and comply with ARARs. Since the stated cleanup goals are based on protection and ARARs, U.S. EPA believes that this approach to evaluating effectiveness of soil and groundwater remediation is consistent with Section 300.430(e) of the NCP.

- Several comments referred to the Thomas Solvent Raymond Road remediation as an example of the failure of current technologies to meet low-level cleanups.

The Performance Evaluation Report (U.S. EPA; April, 1991) for the Thomas Solvent Raymond Road source area reviewed the progress of the remediation to date. In that report, the U.S. EPA noted that it could still take many years for the groundwater extraction system to meet the groundwater cleanup goals. This observation is consistent with other studies of groundwater extraction and treatment systems by the U.S. EPA and others. However, the purpose of the Performance Report was to find ways to enhance the groundwater collection system. One of these ways may be through groundwater sparging. The U.S. EPA is currently planning pilot testing of groundwater sparging and other enhancements at the Raymond Road facility.

The U.S. EPA notes that in areas where the saturated zone soils were not directly contacted by NAPL, groundwater extraction has been fairly effective in meeting the cleanup objectives. Since the extent of NAPL observed at the Annex or Paint Shop is significantly less than what has been observed at the Raymond Road facility, it is possible that the groundwater remediation will proceed more quickly at the Annex and Paint Shop; and it is likely that groundwater remediation will proceed more quickly in the plumes downgradient from the sources where the contaminant concentrations are relatively dilute. Furthermore, in the data from the most recent vadose zone soil sampling effort (January, 1991), VOCs were not detected at a 100 ppb detection limit. This indicates that cleanup objectives may be already met for many of the VOCs (e.g., toluene, xylene, ethylbenzene, 1,1,1-trichloroethane, trans 1,2-dichloroethene) and that cleanup objectives for the other VOCs may be met in the near future. Thus, the U.S. EPA feels that SVE will effectively achieve remediation of the vadose zone soil to meet the soil cleanup objectives.

- Several comments stated that groundwater and soil cleanup goals are below the analytical method detection limits.

In the case where a cleanup goal is below the method detection limit for a given compound, U.S. EPA will generally establish the cleanup goal at the method detection limit. This method has also been adapted by the MDNR under Act 307. However, method detection limits are based on the lowest acceptable detection method available for a given chemical, not on detection limits established by U.S. EPA for routine analytical services (RAS). Because method detection limits vary considerably between laboratories, MDNR has compiled a list of acceptable method detection limits for several compounds regulated under Act 307. In addition, the cleanup goals in the ROD have been adjusted to reflect acceptable method detection limits.

RESPONSE 5

- Several comments were made pertaining to other sources of groundwater contamination within the zone of influence of the Verona Well Field. There was a concern that the other sources of contamination were not considered in the evaluation of alternatives and alternative selection.

U.S. EPA identified and investigated several other potential sources of contamination as part of the final phase of RI work. These other sources included the Raymond Road Landfill, the Grand Trunk Roundhouse, and the Consumer Power property. Soil samples collected at the Roundhouse and Consumer Power properties did not show any indication that these areas are contributing to the contamination in the Verona Well Field. Monitoring wells were installed and groundwater samples were collected in the vicinity of the Roundhouse and the Raymond Road Landfill. Sample results from the Roundhouse did not indicate any groundwater contamination downgradient of that area. Results from the landfill indicated low levels of VOCs are present downgradient of the landfill. However, there is no indication that contaminants migrating from the landfill are contributing to the contamination problem at the well field. The contaminant plume detected downgradient of the landfill appears to be within the zone of influence of the well field but has not migrated more than a few hundred feet from the landfill.

Because the contamination has not affected the well field, U.S. EPA determined that the landfill was not contributing to the contamination of the well field. The landfill is considered to be a separate site and is eligible for ranking as a potential Superfund site. The State also has a program for site remediation under Michigan Act 307 that includes a system for priority ranking of sites based on their actual or potential impacts to human health and the environment. The State has determined that the Raymond Road landfill will be added to the State's list of sites and undergo ranking to determine its priority for remediation under Act 307.

U.S. EPA, MDNR, and the City of Battle Creek have identified additional sources of contamination to the aquifer in the vicinity of the well field that consist of petroleum compounds released to groundwater as a result of gasoline spills and leaking underground tanks at gas stations in the vicinity of the well field. Although these various sources may contribute contamination to the well field in the future, petroleum products are CERCLA exempt, and therefore cannot be addressed under the Superfund program. The MDNR has agreed to address these sites under the State Underground Storage Tank (UST) program. Cleanup of the contamination at two of these sites are already underway.

RESPONSE 6

Several comments were received regarding the technical validity and accuracy of the groundwater modeling performed as part of the FS. Specific comments are as follows:

- One group of comments centered on the procurement of the model code (MODFLOW), modifications that were made to the code, and the resulting accuracy of the code.

The U.S. EPA obtained its model code from the USGS with the multi-aquifer well (MAW) package already incorporated into the model code. It should be noted that the code obtained is public domain software, but had not yet been formally released for distribution. The addition of the MAW package was performed by Michael McDonald, one of the original authors of the MODFLOW code, and has been thoroughly benchmarked by the USGS. Documentation for the apportioning of flow rates is available through the U.S. EPA.

In order to enable the use of this code on a personal computer, the U.S. EPA added statements to the code that enables it to open and close data files. Because of alternative methods of performing this function on a mainframe computer (on which the code was developed), these statements were not included in the code received from the USGS. These statements in no way affect how the data are read by the code, or computations performed by the code. Once these statements were added to the code, the code was compiled and benchmarked against the MODFLOW code that was already publicly distributed. Comparison of the output from these simulations indicated differences in head values of less than 0.001 feet.

- A comment was presented that relates to the relative precision of the code executed on a personal computer as opposed to a mainframe computer.

Using the MODFLOW code obtained from the USGS and the constructed Verona Well Field model, the U.S. EPA has benchmarked the precision of the code between a VAX 8650 mainframe and a personal computer. In these simulations, the output head values indicated differences of less than 0.001 feet.

- A comment was presented that questions the validity of the wseed value used by the strongly implicit solver (SIP) package used as part of MODFLOW to solve the system of equations, and suggests that the head values calculated in the model may be in error as much as 2 feet because of an invalid wseed.

When the U.S. EPA performed the small scale modeling of the Verona Well Field area, a wseed value of 0.005 was used, with a convergence criteria of 0.01 foot (i.e., when all head values showed less than a 0.01 foot change between iterations, the simulation ended) for the final calibration and verification. The U.S. EPA chose this wseed value by modifying it between successive simulations, until the model converged the quickest, was most stable, and produced the smallest volumetric water budget discrepancy. The wseed value chosen by the U.S. EPA is considered to have a slight overshooting effect, which is normally desired for model convergence. Using a larger wseed, the model will have an undershooting effect, and converge at a slower rate. If the wseed becomes to large, the model may converge to soon and the head values may be either too high or too low (depending on the direction of convergence), this effect will cause the volumetric water budget (the tabulation water inflow and outflow in the model, ideally zero) discrepancy to increase. The U.S. EPA has simulated the calibrated Verona model over a wide range of wseed values, including utilizing the capability of the model to calculate its own wseed value. The results are as follows, with the residual referring to the difference between the calculated head using the specified wseed, and the calibrated head values presented in the FS:

WSEED VALUE	RESIDUAL (ft)	% DISCREPANCY IN WATER BUDGET	NO. OF ITERATIONS
0.0001	Model unstable, would not converge		
0.0005	< 0.01	0.65	32
0.005	as calibrated	0.88	42
0.01	< 0.1	1.58	62
0.05	< 0.2	1.97	62
0.10	< 0.4	2.59	64
model calculated	< 0.01	0.65	32

The results of this exercise clearly indicate that the use of a larger wseed in this instance causes discrepancy to increase in the volumetric water budget of the model, as well as increasing the time required for convergence, while decreasing the accuracy of the model.

In addition to the above simulations, the U.S. EPA ran the calibration simulation using the preconditioned conjugate gradient (PCG) solver package for MODFLOW (this package was not available during the Verona modeling, but is currently publicly distributed). The PCG is a preferred solving technique because the mathematics behind it are inherently more stable, and it does not require the specification of a wseed value, only the closure criteria (0.01). Output from this simulation indicated a residual (as defined above) of less than 0.1 foot, a volumetric water budget discrepancy of 0.49 percent, and converged in 24 iterations.

Given the information presented above, the U.S. EPA believes that the modeled potentiometric data presented in the FS are precise to the ability of the model code and the models calibration. The U.S. EPA does not believe that the solving technique used during the simulations caused errors of up to 2 feet in the modeled head values.

- A comment was presented that questions the validity of several cells within the small scale models upper layer going dry during model simulations.

In two areas within the small scale model (the central portion of the well field and the northeast corner of the study area), cells in layer 1 tend to dry up during simulation. Layer 1 of the model corresponds to the unconsolidated deposits that overly the bedrock in this area. In these areas of this layer the elevation of the bottom of the unconsolidated deposits is **above** the measured potentiometric head elevations, and thus cells pertaining to these areas in the model dry up. The model simulates this effect accurately, as concluded by comparing the paleotopographic map of the top of the bedrock and a potentiometric map of the well field area.

- A comment was presented that questions the reliability of the MODPATH particle tracking that was performed in conjunction with the groundwater flow modeling, and suggests that some of the wells simulated may be acting as weak sinks which may produce an optimistic capture zone analysis.

To perform a particle-tracking analysis, MODPATH uses the input and output datasets from the MODFLOW model. Input consists of typical MODFLOW parameters such as the geometrics for the model, as well as horizontal and vertical hydraulic conductivity values. In addition, MODPATH requires as input, the output modeled head data for each layer of the model, as well as a complete mass balance for each cell in the model. The mass balance for each model cell contains a value of inflow or outflow for each face of the cell, as well as flow data for any internal sinks or sources within the cell. A weak sink is defined as a sink that does remove all available water entering a cell (i.e., inflow into the cell is greater than the specified discharge of the sink or, in this case, well).

During a MODPATH simulation, there are three variables or options that can affect the movement of a particle. These are as follows:

a) The specification of a porosity value for the aquifer material.

b) The specification of artificial zones within the model at which particles may be removed.

c) The specification as to whether or not particles are to be removed by a weak sink. If particles are removed by a weak sink, the simulation would be considered liberal; if they are not, then the simulation would be considered conservative.

During the MODPATH simulations performed by the U.S. EPA, a value of 34 percent was used for the porosity of the aquifer materials, and should be considered conservative in that when used to calculate a groundwater velocity, the velocity would tend to be slightly low. This porosity value is consistent with the values used throughout the RI/FS.

While the option to use artificial zones to remove particles within the model can be invoked, the U.S. EPA used no such zones during MODPATH simulations.

For all MODPATH simulations, the U.S. EPA opted not to allow the model to remove particles from the model via the use of a weak sink. This is irrelevant, however, since by examining the mass balance data for cells that include a sink, these would be considered strong sinks.

When outlining the capture zones for the proposed wells, the U.S. EPA used the particle-tracking output and the groundwater flow model output, and believes that the capture zones outlined compare favorably with both output data sets.

The U.S. EPA would also like to note that they acknowledge the limitations to the MODFLOW and MODPATH modeling, that the proposed area of the new purge wells, hydraulic conductivity data is very sparse, and that prior to the installation of a complete system, testing should be performed in this area to obtain hydraulic conductivity values as well as the radius of influence of such a well.

- A comment was presented that questions the depth to which the new blocking well system would penetrate into the aquifer, and suggests that full penetration would be necessary.

The installation and operation of fully penetrating wells would have the effect of continually drawing the contamination deeper into the aquifer. . This is due to the higher conductivity of the lower portion of the aquifer compared to the upper portion of the aquifer. By operating a well that is screened through both portions of the aquifer, a much greater volume of water will be removed from the lower aquifer, drawing contaminants downward. By installing the new blocking wells at 50 to 70 percent penetration of the aquifer (depending on location), it is believed that the wells will capture the contamination without drawing it deeper into the aquifer.

- A comment was presented suggesting that in the U.S. EPA modeling logs, a verification run was performed on data obtained in 1984, and there was a 5-foot head discrepancy. Also, no axial well simulations were performed.

The U.S. EPA performed no verification run using data from 1984. The verification run used data from 1989, and had an average discrepancy in the Raymond Road area of 1.48 feet (layer 1), 1.21 feet (layer 2) and 2.00 feet (layer 3).

The U.S. EPA never performed, nor suggested that any type of "axial well" simulations were performed.

- A comment was presented that suggested that the original USGS model of the Verona well field could have been executed on a 80386-based minicomputer.

It would have been possible to execute the USGS model on a 80386-based microcomputer, if the computer was capable of 32-bit processing and had sufficient extended memory. Since all parties involved (i.e., the U.S. EPA and the USGS) did not have these capabilities, it was determined to modify the model to run on any microcomputer.

- A comment was presented that questioned the justification of reducing the precision of the USGS model to run on a microcomputer, and suggested that the grid spacing of the USGS model was superior to the U.S. EPA local model, and that no modification was necessary.

The original USGS model was large and cumbersome to work with, with a slow execution speed. The model grid had relatively tight descretization in the area of the well field, but expanded to 100 x 500 foot spacings in the area of Raymond Road and the Annex. The model was developed to analyze the well field, but was insufficient to apply to the remediation simulations at Raymond Road, the Annex, and the paint shop.

The U.S. EPA modified the USGS model so that it executed faster, and would provide only boundary condition information, to be input onto a small scale model that had a refined grid (100 x 150 foot) spacing in the source areas.

- A comment was presented that suggested that the modifications to the USGS model be verified by comparing output from the model to that of the original model.

Since the modifications to the original USGS model were so extensive, the U.S. EPA believes that calibrating the modified model to existing data to be more prudent. Results of this calibration are presented in Appendix D of the FS.

- A comment was received that suggests that the utility program "modrot" that was used to transform the USGS data to the new model grid needs documentation and verification to indicate whether or not it is properly functioning.

Documentation and verification cannot always justify the proper functioning of a utility program. The only method that can insure the proper functioning of such a utility program is to perform the transformation, then contour plot both sets of data and check for any discrepancies. This procedure was performed for all datasets from the USGS that were transformed, then the corresponding output was reviewed by both the U.S. EPA and the USGS to detect any discrepancies.

- A comment presented suggests to present the sensitivity analysis, the use of a separate contour map for each model layer, for each sensitivity run.

Including this level of documentation in the FS would effectively triple the size of Appendix D, without providing any significant information to the general reader. These contour plots are part of the U.S. EPA modeling logs, which have been made available to interested parties.

- A comment presented suggests that the magnitude of variation in the sensitivity analysis was too large.

During the sensitivity analysis, the model appeared to be somewhat insensitive to many of the input parameters. To fully appraise the effect these parameters had on the model, it was necessary to increase the range of variation typically used during a sensitivity analysis.

- A comment was presented indicating a discrepancy in Appendix D. In one instance, reference is made to a stream loss of 2 cfs measured by the USGS in the well field area, while in other instances a value of 2.5 cfs is used.

A value of 2.5 cfs stream loss was measured by the USGS, and the calibrated model simulated stream loss at 2.4 cfs.

- A comment was presented that asks to define the term "root mean square error."

The "root mean square error" is simply old terminology for the term "standard deviation."

- A comment was received that suggests tables that list calibration residuals for the calibration and verification simulations be present in the FS.

These tables were compiled for model simulations, and were made part of the U.S. EPA modeling logs. These logs have been made available to interested parties.

- A comment was presented that indicates a discrepancy between a model dataset and Table D-1 (a list of wells and corresponding pumping rates) of the FS. It appears that two wells were presented in the data set for Grand Trunk Western Railroad, where only one is present on Table D-1. Also that a Bailey Park well listed in Table D-1 was not included in the dataset and that a well named "Columbia" was in the dataset but not presented in Table D-1.

Grand Trunk Western Railroad operates two wells in the area of the Verona Well Field. In the regional model, since both wells were located within the same cell of the model, their discharge was combined and simulated as a single well discharging 100 gpm. In the local scale model, these wells were located in different cells, so they were each simulated separately at 50 gpm each.

All Bailey Park wells, V-14, V-15, and V-17 are present in both the dataset and Table D-1.

The well named "Columbia" refers to the Columbia township well that is within the boundaries of the regional model, but outside the boundaries of the local model. It was inadvertently left off Table D-1.

- A comment was received that suggests that the particle-tracking maps should be drawn indicating travel time and the entry-exit point of each particle for each layer.

The drawing of such a map would become very confusing given the number of particles used in the simulation. Instead, the U.S. EPA opted to project the 3-D location of the particle track onto a 2-D surface. In addition, an example of the particle travel time analysis is presented in Figure D-26.

- A comment was received that suggests that the model was calibrated poorly, especially in the area of the Annex, and that there is a significant difference in flow direction between the model and field data in the area of the Annex.

Appendix D of the FS states that the calibration process (local scale model) achieved a standard deviation between model output and measured field data of 1.72 feet (layer 1), 2.71 feet (layer 2), and 1.35 feet (layer 3). In addition, in the area of the Annex, the calibration process achieved a standard deviation between model output and measured field data of 0.39 foot (layer 1), 0.73 foot (layer 2), and 0.27 foot (layer 3). The U.S. EPA believes this calibration is adequate for the intended use of the model.

In general, data interpreted manually or mechanically in the form of a contoured potentiometric map lack the insight into the hydrogeology (i.e., effects from changes in geology or hydraulic properties) that a model possesses when it calculates the potentiometric head values within the model. It is for this reason that the U.S. EPA refrains from calibrating a model based on an interpreted flow direction.

The U.S. EPA calibrated the Verona model on collected potentiometric data, and maintains the general tendencies seen in this data. In the unconsolidated deposits in the area of the Annex, the field data (for February and October, 1989) indicate a north-northwest trend in the groundwater flow, the same general trend is present in the flow directions observed in the groundwater flow model output. In the sandstone aquifer, field data indicate a flow direction from the Annex area northwest, and the same trend is observed in the output from the groundwater flow model. In addition, the axis of contaminant plumes in both aquifers appears to have a northwest to north-northwest trend.

RESPONSE 7

Several comments were also received pertaining to the specific development and description of alternatives in the Public Comment Feasibility Study. The comments are as follows:

- One comment stated that the FS falsely assumed that expedited cleanup times is one of the nine criteria listed in the NCP for consideration in evaluating proposed remedies.

Section(e)(9)(iii)(E)(4) of the NCP requires that "time until protection is achieved" be considered as one of the factors to be assessed under short-term effectiveness; one of the nine criteria.

- One comment inquired as to why the FS did not provide a cost evaluation as part of the alternative screening process.

No cost evaluation was presented in the alternative screening process because this FS did not screen the alternatives before detailed analysis. Following screening of technologies, there were a limited number of alternatives and U.S. EPA did not believe additional screening would eliminate any of the alternatives. While alternative screening is often done in feasibility studies, it is not required by the NCP or the "Guidance for Conducting Remedial Investigation/Feasibility Studies Under CERCLA," Interim Final, October, 1988.

- Various comments suggested the contaminant mass estimates were either unrealistically high or too low.

The U.S. EPA acknowledges that contaminant mass estimates are often inaccurate and variable. It is also recognized that there is a wide variability in the mass estimates using the kriging method, particularly at the Annex. This variability is due to one "hot spot" at SB-11. However, based on the available data, the U.S. EPA feels that these estimates are a fair prediction of the contaminant mass. Contrary to one comment, the U.S. EPA did not use the maximum contaminant mass estimate for the Annex and so bias the alternative evaluation. The maximum mass estimate at the Annex was 62,000 pounds (Table A-1). The U.S. EPA used a modified average of 37,000 pounds in the development and evaluation of alternatives for the Annex (Table A-2). The variability of the mass estimates did not affect the selection of SVE for soil treatment at the Annex or at the Paint Shop (The mass estimates did affect the assumed type of off-gas treatment, but not the need for off-gas treatment).

- One comment suggested that there were other "hot spots" of soil contamination around the Paint Shop.

Most of the contamination at the Paint Shop centers around the drum pit. Hot spots of soil contamination may exist around the paint shop, particularly around SB-27 as discussed in Technical Memorandum No. 4. It is possible that other hot spots also exist around the paint shop where solvents may have been spilled or disposed of. While this possibility may indicate a need for further sampling before SVE design and implementation, it does not affect the remedy selection or the need to treat the known contaminated soil.

- Two comments suggested that in situ bioremediation has potential for the site. One comment questioned if the basis for estimating the duration of bioremediation had been adequately presented in the FS.

The U.S. EPA agrees that in situ bioremediation may have potential for the site. The FS included a detailed study of the current feasibility of using in situ bioremediation for chlorinated VOCs (Appendix H). The U.S. EPA has concluded that currently in situ bioremediation for chlorinated VOCs has not been sufficiently demonstrated to warrant inclusion in the proposed plan. It may be considered in the future as more pilot studies are completed and more field data are presented on its success in meeting low cleanup levels for chlorinated VOCs.

In Appendix H, it was estimated that in situ bioremediation could take 7 years to 5 years for the anaerobic phase and 2 years for the aerobic phase. As discussed in Appendix H (page H-8), the length of anaerobic treatment was based on the half life chlorinated VOCs observed in an anaerobic environment. The length of aerobic treatment was based on the time needed to deliver sufficient oxygen and methane to the microbes to biodegrade the contaminant mass. Both of these times are only estimates and would need to be revised after bench scale testing of the bioremediation system.

- Several comments were made pertaining to the i) need for off-gas treatment for the SVE system ii) the justification for the type of off-gas treatment selected in the FS and iii) that catalytic oxidation is not a proven technology for chlorinated VOCs.

The requirements of Michigan's Act 348 are presented in the FS on page 3-14. Generally, compliance requires attainment of an excess cancer risk of 1 x 10^{-6} for air emissions. In addition, all new sources of VOCs must be treated with best available control technology. Consequently, the FS assumed that off-gas treatment would be required for the SVE systems and air strippers. Catalytic oxidation was selected as the best off-gas treatment for the Annex, and vapor phase carbon was selected for off-gas treatment at the Paint Shop. As discussed on page 5-32 and discussed further in Appendix G of the FS, the basis for these selections was cost effectiveness based on the estimated contaminant mass at each source area. Catalytic oxidation was used effectively at Raymond Road source area for off-gas treatment, and so the U.S. EPA considers it to be a proven technology. The final treatment process option will be determined during the remedial design.

- One comment stated that incineration should not have been developed into an alternative. Another felt that the time estimated to complete incineration was too short. The comment also stated that offsite disposal of the treated soil should have been discussed since it is not clear that the treated (incinerated) soil could be delisted.

Thermal treatment was carried forward as an alternative because of its ability to meet soil remediation goals more quickly than SVE. Ultimately, thermal treatment was not included in the proposed plan because it was not cost-effective or as implementable as SVE. The actual time needed to complete incineration would depend on the type of thermal treatment process option selected and the size of the unit. Commercial, mobile incinerators are available that could feasibly treat the soils in 7 months. The U.S. EPA feels this is a reasonable assumption for the FS.

The FS did assume that treated soil could be delisted and placed back onsite. For the type of soil and nature of contaminants, the U.S. EPA feels this is a valid assumption. Meeting delisting criteria would have had to have been demonstrated during bench scale and pilot testing had incineration been selected for the proposed plan.

- One comment stated that pretreated (e.g., air stripped) groundwater could be discharged to the POTW and this option should be retained.

Assuming that air stripping is required for either discharge to a POTW or to the Battle Creek River, the U.S. EPA did not see any advantage, cost or otherwise, for discharging to the POTW. Furthermore, the Battle Creek POTW did not want to receive the groundwater.

- One comment suggested that "passive flushing" should have been considered as treatment under the no action alternative since this has been considered at other Superfund sites.

The U.S. EPA does not consider passive flushing a viable alternative at this site. Passive flushing would not meet any of the ARARs or the goals of the remediation in a timely manner. Furthermore, it may be less expensive to remove the contaminants with SVE than to allow leaching into the groundwater and removal through groundwater extraction, either at the source areas or the well field. The U.S. EPA has selected passive flushing at other Superfund sites, but does not select passive soil flushing at sites where groundwater ingestion is an exposure pathway.

- Numerous comments were made pertaining to the size, layout, and specification of the SVE and groundwater extraction systems. Specific comments included that:

- It is unclear if passive air injection (versus active air injection) is to be used for SVE at the Annex.
- The SVE systems were oversized. Sizing should be based on a 10-year operational period (instead of 2 to 5 years).
- A pilot test would not be needed.
- Spacing of the groundwater extraction wells was too conservative.
- The optimum sequence for air stripping and activated carbon was not correct.
- The effect of iron was not considered in the groundwater treatment technologies.

In response to all these comments, the U.S. EPA notes that final layout, sequencing, and sizing of technologies is to be determined during the remedial design. The purpose of the FS is to make reasonable estimates, evaluate alternatives on those estimates, and to select the best alternative. Groundwater pump tests, SVE pilot tests, and further soil sampling will all affect the final design of remedial technologies. The following responses are also made to particular comments.

First, the FS assumed the use of active (forced) air injection. Passive air injection would be considered, but its effectiveness would have to be demonstrated in a pilot test. Second, the U.S. EPA doubts that a scaled down system operating for a longer period of time is necessarily more cost effective. Capital costs for SVE systems are relatively inexpensive compared to the operational cost. Third, even with the U.S. EPA's experience at Raymond Road, a pilot test would still yield important information such as the initial extraction rates of VOCs and the effectiveness of passive/active air injection. Fourth, final spacing of the groundwater extraction wells will be based on aquifer pump tests at each of those locations. Fifth, the optimum sequence of activated carbon and air stripping will be determined in the design phase. The sequencing suggested in the FS was based on the assumption that the liquid phase carbon would temporarily be placed in front of the air stripper to minimize loading to the air stripper. This would enable its size to be minimized. The U.S. EPA notes that the air stripper will need vapor phase treatment (e.g., vapor phase carbon) and this must be considered in the sequencing of the two technologies. Sixth, the problem of iron precipitation on the operation on an air stripper is acknowledged (page F-5). The high O&M requirements presented by iron precipitation is one reason why a 5-year life of the air strippers was assumed. It has been the U.S. EPA's experience that iron precipitation will add significant expense to the O&M of an air stripper. The U.S. EPA agrees that, if the problem is severe, pretreatment of iron and other metals may have to occur before air stripping.

- Several comments questioned the methodology used to estimate influent concentrations for the groundwater treatment systems at the source areas. One comment inquired why there was a difference between the average concentrations presented on Table 3-1 and the influent concentrations used in Appendix F. Another comment asked why acetone, methylene chloride, chloroform, and chlorobenzene were not considered in the design of the air stripper.

The estimates of groundwater concentrations presented in Appendix F of the FS were derived from the 1989 groundwater data. These average concentrations allowed reasonable estimates to be made for the size of the air strippers at the various source areas. While it is acknowledged that the actual concentrations observed during remediation at the source areas may vary from those in the FS, the averages provided a good basis for estimating design criteria.

The concentrations presented in Table 3-1 of the FS were taken from the risk assessment which included concentrations of one half the detection limit for samples where a compound was not detected. Table 3-1 concentrations are presented solely for comparative purposes. They are generally higher than those concentrations presented in Appendix F which averaged only detected compounds.

Acetone, methylene chloride, chloroform, and chlorobenzene were not considered in the design criteria of the air stripper because they were not detected at concentrations exceeding their cleanup objectives with any frequency. They are not expected to require removal in the final air stripper design. Because these compounds were detected in so few samples, the averages presented in Table 3-1 may be artificially high for the reasons stated above.

- Some comments were made on the locations of the air strippers and one comment pointed out that air stripping at the Paint Shop could violate space requirements for the required area between a residence and a treatment system.

The U.S. EPA does not consider the placement of air strippers as shown in the FS to be final. The placement of air strippers in the FS considered the economies of scale for fewer air strippers and ease of operation. However, final placement will be determined in the remedial design.

- Numerous comments were also made in regard to the cost estimate. General comments varied from saying the estimated costs were exorbitant to suggesting that the costs were too low. Specific comments included:

  - The assumed equipment lives were too short.
  - Why were two activated carbon systems included in the Alternative 6 cost estimate and why does Alternative 5 include a line item for activated carbon at the source extraction wells?
  - Why were the present worth costs calculated with a 15.1 present worth multiplier?
  - What activated carbon loading amounts were used in estimating carbon usage?
  - Why are the per foot costs of SVE well installation more at the Paint Shop than the Annex?
  - The cost estimate did not include air scrubbers for treatment of HCL in the SVE offgas.
  - Air monitoring costs were not consistent between Alts. 5 and 7.

It is difficult for the U.S. EPA to respond to general comments saying the cost estimate was too high or too low. The U.S. EPA feels that the estimated costs presented in the FS are a fair and realistic estimate, within the accuracy of FS level cost estimates which have a required accuracy of +30, -50 percent. Many of the estimated costs reflect actual costs incurred with SVE and air stripping at the Raymond Road source area and in the well field. One comment confirmed the basic accuracy of the air stripping and SVE cost estimates with independent cost estimates of these items. While the final costs will certainly vary from these estimates, the estimates were useful for the purpose of selecting an alternative that was cost effective as well as protective of human health and the environment.

In responding to the specific comments, the U.S. EPA acknowledges that much of the groundwater pumping and treatment equipment may last more than 5 years. However, past experience has shown that iron precipitation will add considerable expense to maintaining the well screens, pumps, and air stripper. Thus the actual costs represented by assuming a 5-year life are realistic.

Second, an allowance for activated carbon should have been included only once for Alternative 6 and not at all for Alternative 5. Neither of these would have a significant effect on the cost estimates for the respective alternatives.

Third, the present worth of the operation and maintenance costs at a 5 percent interest rate was calculated with a 15.1 present worth factor instead of the 15.37 which is more commonly used. The U.S. EPA notes that the difference between these two present worth factors is less than 2 percent and is inconsequential given the stated accuracy of a FS level cost estimate.

Fourth, vapor phase carbon usage was estimated based on a 14 percent loading efficiency, which is the efficiency observed during the remediation at the Raymond Road source area (see page G-11).

Fifth, the estimate per linear foot of well installation at both source areas should have been 155 dollars per foot (not 540 dollars per foot at the Paint Shop as shown on Table I-6).

Sixth, in response to the need for scrubbers to remove HCL from the offgas, the U.S. EPA notes that this potential was discussed on page G-11. The U.S. EPA feels that scrubbers would probably not be needed, so no allowance was included for them in the cost estimate.

Seventh, air monitoring costs should be $452,000 for both alternatives.

RESPONSE 8

Many comments were received that suggested other alternatives be considered. These included:

- No action (with some monitoring and continued operation of the blocking wells)

The U.S. EPA feels that implementing SVE would be more protective of human health and more cost effective than allowing "passive flushing" to slowly leach the contaminants into the groundwater where they are more difficult and costly to remove. SVE will likely meet the soil cleanup goals within a few years. Most comments agreed on the need for soil treatment and the selection of SVE as the most effective soil treatment technology. Passive flushing would not meet cleanup goals, especially those specified under Act 307, for the foreseeable future. The U.S. EPA did not select a no action alternative for the soil because it is not protective of human health, will not meet ARARs, and is not cost effective.

- SVE at the source areas and modified blocking well system (No groundwater extraction wells at the source areas)

One comment suggested only SVE at the source areas and optimization of the existing blocking well system. The comment questioned the need for groundwater extraction wells at the source areas because groundwater extraction may never meet the cleanup objectives and the pace of remediation is not a sufficient reason to include source area groundwater extraction. This comment is addressed under Response #1B.

- SVE at the source areas, groundwater collection at the source areas, modified blocking wells, and possibly collection wells between the sources and the existing blocking wells

Numerous alternative arrangements to the new purge wells were proposed. These included modifying the existing blocking well line, adding more monitoring wells near the Bailey Park wells, and installing several new extraction wells downgradient from the sources in an orientation parallel to the direction of the plumes instead of perpendicular as proposed in the FS. The U.S. EPA is most concerned with protection of the well field and restoring the aquifer downgradient from the source areas. Installation of additional purge wells is one way to achieve these objectives. Other configurations of additional blocking/extraction wells will be considered by the U.S. EPA during design phase. The U.S. EPA's position on alternative purge wells is discussed more fully under Response #1B.

ATTACHMENT II

STATE OF MICHIGAN

JOHN ENGLER, Governor

DEPARTMENT OF NATURAL RESOURCES

STEVENS T. MASON BUILDING
P.O. BOX 30028
LANSING, MI 48909

DELBERT RECTOR, Director

June 28, 1991

Mr. Valdas Adamkus, Regional Administrator
U.S. Environmental Protection Agency
Region 5, 5RA-14
230 South Dearborn Street
Chicago, Illinois 60604

Dear Mr. Adamkus:

The Michigan Department of Natural Resources (MDNR), on behalf of the State of Michigan, has reviewed the Record of Decision (ROD) for the Verona Well Field Superfund site (Calhoun County) final remedial action, and the proposed remedy contained in that ROD. The State concurs with the remedy proposed in the ROD consisting of: 1.) groundwater extraction and treatment in conjunction with soil vapor extraction and treatment at the Thomas Solvent Annex and the Grand Trunk Western Railroad (GTWRR) paint shop, 2.) continued operation and maintenance of the existing blocking wells and associated groundwater treatment system, 3.) installation and operation and maintenance of an additional set of blocking wells and associated groundwater treatment system, 4.) continued operation and maintenance of the existing groundwater extraction and treatment system and soil vapor extraction and treatment system at Thomas Solvent Raymond Road, and 5.) monitoring of the groundwater in the area. The ultimate goal is to remedy all contaminated soil and groundwater such that it meets all Applicable or Relevant and Appropriate Requirements (ARARs) and cleanup objectives.

The State also generally concurs with the analysis of ARARs contained in Appendix B of the public comment draft feasibility study for this site dated February 1991. However, the substantive portions of the Michigan Hazardous Waste Management Act, (1979 P.A. 64, as amended) should be included as an ARAR. The State and the U.S. Environmental Protection Agency (EPA) have agreed that the "portions of Act 64 that are more stringent than RCRA Subtitle C would be applicable for the Verona Well Field site" (Section XI, B, 3 of the ROD). In addition, the State does not concur with the omission of the Michigan Water Resources Commission Act (1929 P.A. 245, as amended), MCL 323.6(1) and the associated Part 22 Administrative Rules MAC R.323.2201 et.seq. from Appendix B of the Feasibility Study and from other references. The State has previously identified these requirements as ARARs for the remedial action being selected for this site. The State still considers these as ARARs.

It is the Department's judgement that the selected remedial actions for this site will provide for attainment of all State ARARs including the Michigan Water Resources Commission Act and Part 22 Rules. The remedial action will halt the migration of contaminated groundwater and eventually restore the aquifer to a usable condition.

The State is concurring in the ROD with the understanding that Tables 16 and 17 in the ROD are being revised to incorporate all indicator compounds that EPA and MDNR have agreed upon. Specially, we understand that carbon tetrachloride and benzene will be added to the final list of soil indicator compounds (Table 17 of the ROD). Finally, it is the State's understanding that all cleanup numbers for the remedy (both indicator compounds and the remaining identified compounds of concern) will be at least as stringent as the Type B criteria for these compounds established pursuit to the Michigan Act 307 Rules.

We are pleased to be partners with you in selecting this remedy and look forward to working together to accomplish the final remedy at this site.

Sincerely,

Frank Ruswick
Acting Deputy Director
517-373-7917

cc: Mr. Jonas Dikinis, U.S. EPA
Ms. Susan Louisnathan, U.S. EPA
Ms. Margaret Guerriero, U.S. EPA
Mr. Robert Reichel, Dept. of Attorney General
Mr. Alan Howard, MDNR
Mr. Andrew Hogarth, MDNR
Mr. Robert Hayes, MDNR
Ms. Nanette Leemon, MDNR
Mr. William Bradford, MDNR
Mr. Brady Boyce, MDNR
Ms. Beth O'Brien, MDNR